LONG ISLAND SOUND

WATER RESOURCES INVESTIGATION

TIDAL-FLOOD MANAGEMENT STUDY

THAMESVILLE, CONNECTICUT

RECONNAISSANCE REPORT

STAGE 1

Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
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INTRODUCTION

PURPOSE AND SCOPE

This Reconnaissance Report provides a planning and management tool in the development of alternative solutions to reduce tidal-flood damage in the Thamesville section of Norwich, Connecticut, and considers the desirability of implementing recommendations contained in previous reports and/or adopting further measures for reducing the potential for tidal-flood loss. This report identifies past and potential tidal-flood damage. Published information, public participation and engineering judgment will determine the problems, needs and opportunities of the Thamesville area.

This reconnaissance investigation is intended to determine whether there is significant existing or potential tidal-flood damage, whether local interests favor further investigation, and whether a more detailed study is warranted and recommended. This report will identify the appropriate scope of study, the level of detail required to formulate intermediate plans, and significant policy issues. It will be used as a guide to develop feasible, implementable tidal-flood damage reduction measures.

AUTHORITY

This study is authorized by a Resolution of the Senate Public Works Committee, adopted 22 September 1970, which states:

> "That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be and is hereby requested to review the report on the Land and Water Resources of the New England-New York Region, transmitted to the President of the United States by the Secretary of the Army on April 27, 1956, and subsequently published as Senate Document Numbered 14, Eighty-fifth Congress, with a view to determining the advisability of improvements in Long Island Sound, New York and Connecticut in the interest of flood control, navigation and related purposes with due consideration for enhancing the quality of the environment."

Further impetus for this investigation of tidal flooding at the Thamesville section of Norwich, Connecticut is a result of a recommendation of the Long Island Sound Regional Study (LISS) completed in 1975.

This Federal-State comprehensive study produced a plan submitted by the New England River Basins Commission to the President's Water Resources Council. The plan included a recommendation that alternate ways of protecting lives and property in seven tidal-flood prone Connecticut areas be studied by the Corps of Engineers. The seven areas are Thamesville, Fairfield, Montville, New London, Old Lyme, Stratford and Westport. The studies would serve as a model for design and adoption of programs and policies for tidal-flood plain management throughout the coastal area. Thamesville has been selected as the initial area for detailed study. Initial study area findings could serve as a model for design and adoption of programs and policies for tidal-flood plain management throughout the coastal area.

SECTION II

STUDY AREA

STUDY AREA

GENERAL

The State of Connecticut's extensive frontage along the Atlantic Ocean lies mostly on Long Island Sound. Three major rivers divide the state: in the extreme west, the Housatonic River runs from Massachusetts into Long Island Sound; the Connecticut River, the largest of the three, bisects the state; and on the easterly coast, the Thames River, actually an estuary formed by the confluence of the Yantic and the Shetucket Rivers at Norwich, joins the ocean at New London.

The area from Norwich south to New London along the Thames is a Standard Metropolitan Statistical Area (SMSA) which also includes the towns of Groton, Old Saybrook, Bozrah, Cariswold, Lisbon, Old Lyme, Sprague, Montville, Preston, Ledyard, Stonington, Waterford, and East Lyme. The 1975 population of this SMSA was 251,609, a four percent increase over 1970. New London and Groton share New London Harbor and are both heavily industrialized. Norwich is to the north, in the center of an area of scattered industrial interests located on the Thames River.

LOCATION

The Thames River drains a watershed of 1,382 square miles at the southern corporate limit of Norwich. Subject to mean tidal fluctuations of 2.6 feet at New London Harbor and 3.1 feet at Norwich, the Thames drains a major portion of eastern Connecticut and portions of western Rhode Island and southern Massachusetts. The Thames River is maintained as a navigable channel (25' depth) from Long Island Sound at New London northward to Norwich.

The city of Norwich is located in the southeastern portion of Connecticut in north-central New London county. The city of New London is 12 miles to the south. Norwich is bordered by Sprague on the north, Franklin and Bozrah on the west, Lisbon and Preston on the east, and Montville on the south.

There are a number of small settlements in the city known by separate names including Occum, Greenville and Thamesville. The latter denotes a cluster of industrial plants along a narrow level shelf formed along the westerly bank of the river and a cluster of residential properties around the intersection of Dunham and West Thames Streets. Conrail passes along the inner edge of this shelf. The river has a depth of 25 feet (MLW) and has good docking facilities along its banks. Thamesville lies approximately 0.7 miles downstream of the junction of the Yantic and Shetucket Rivers.

In the low-lying study area there are approximately 42 structures consisting of: 10 residential, 12 commercial, 8 industrial and 12 large storage tanks. These businesses (on the 36 acre site) include bottled gas, wholesale meat, fire distributor and manufacturers, display designers and producers, two large oil companies (one is Connecticut's largest home heating oil distributor) and a large scrap metals company.

CLIMATOLOGY AND STORMS

The climate of the Thames River basin is typical of lower coastal New England. It is varied and characterized by short periods of heavy precipitation typical of its latitude and location within the North Temperate Zone.

New England is influenced by constant conflicts between the cold dry air flowing out of the northwestern subpolar region and the warmer moisture-bearing tropical air from the south. Most of the general cyclonic disturbances skirt the polar front bringing them through the region in a somewhat regular succession of biweekly storms. Wettest storms are those in which the moist southwest or east winds flow over the uplands and are forced aloft over cold resident air to a level where they condense. In addition, severe coastal disturbances occur when deep low pressure areas pass over or near the basin area. A storm of tropical origin reaching the area at peak intensity, known locally as "nor'easters", are heavily laden with moisture since it has passed mostly over water prior to coming inland.

Winter storms often bring rainfall to the Thamesville area. The southern portion of the watershed, due to its proximity to the Atlantic Ocean and Long Island Sound, escapes the severity of cold and depth of snowfall experienced at the higher elevations in the northern part of the watershed. Orographic influences on the climate are minor. Hurricanes can occur, particularly during August, September and October.

Average annual precipitation over the Thames River basin is about 47 inches, varying from about 50 inches near the coast to about 44 inches in the upland areas northwest of Southbridge, Massachusetts. The average annual precipitation for Norwich is approximately 42 inches. Distribution of precipitation throughout the year is rather uniform.

The average annual snowfall over the watershed varies from about 30 inches near the coast to more than 50 inches in the upper portions of the watershed. In the early spring, water content of the snow cover seldom averages more than 2 inches over the entire basin. However, 4 inches or more have been experienced occasionally in the higher altitudes.

HYDROLOGY

The average annual runoff for the Thames watershed, based on available records, is approximately 22.5 inches or just under 50 percent of the average annual precipitation. This runoff translates into 1.64 cubic feet per second (cfs) per square mile of drainage area in both direct runoff and groundwater outflow into surface waters. The balance is lost through evapotranspiration.

There are seasonal as well as geographic variations in runoff. Although average monthly precipitation is fairly uniform throughout the basin, evapotranspiration causes higher water loss and less runoff in the summer months, while lower temperatures and spring thaws cause high winter and spring runoff. More than one half of the annual runoff occurs in the months of March, April and May while the rest is rather uniformly distributed throughout the remainder of the year. Groundwater outflow is a major contributor to surface water flows during the winter and summer months.

The patterns of runoff discussed above determine the quantity of water in the basin's, rivers and lakes. At Norwich, where the major tributaries come together and the Thames Estuary begins, annual flows equal 530 billion gallons per year (2,247 cfs).

Runoff is also retained in approximately 410 lakes and ponds in the basin. The largest in both surface area and total storage is Mansfield Hollow Reservoir, a Corps of Engineers flood control impoundment, with 1,880 surface acres and 16,900 million gallons (MG) storage. Lake Webster, or Chaubunagungamaug, in Massachusetts is second in size, with 1,181 surface acres and 1,552 MG storage.

GEOLOGY AND TOPOGRAPHY

The general topography is rolling hills and valleys. Rounded hills rise to over 500 feet on Plain Hill, the highest point in Norwich, to under 10 feet at the Thamesville area. The geology is characterized by granite-gneiss and schist bedrock overlain by glacial till and stratified drift. Bedrock lineations trend in a north-south to northeast-southwest direction. The till-variable, unsorted silty gravelly sand with cobbles and boulders-is thin on hills and thicker in valleys. Stratified sand and gravel was deposited over the till by glacial meltwater and fluvial action and is concentrated in the valleys.

The soils associations occur in a complex pattern and are highly variable in terms of depth, stoniness, and rockiness. Soils in flood plain areas are generally free of stones, while upland areas and steeper slopes are stony to rocky. The soils are well drained, except in the many cases where they are underlain by a hardpan or slowly permeable substrata.

FISH AND WILDLIFE

An inventory of fish and wildlife resources is included as Appendix A.

ECONOMIC PROFILE

Overview - Agrarian settlements were established in the Thames River basin in the 17th century. The early towns of New London, Groton, and Norwich served as mercantile centers for these settlements. Although nearly all of the watershed was cleared for agriculture before the 19th century, by the mid-1800's production from the thin, rocky New England soils could not compete with that of the more fertile western states. At the same time, manufacturing industries, particularly textiles and paper, began to develop in the Shetucket Valley and in the Quinebaug and French River valleys. Railroad lines generally reinforced this development pattern.

Economic forces outside the region started a long term industrial decline in the early 1900's. The manufacture of textiles was superseded by that of chemicals and Navy submarines after World War II, particularly in the Thames Estuary. A significant factor in locating these later industries was the availability of water for processing, power and transportation. However, in the more inland areas water ceased to be a major determinant of industrial development.

Until the mid-1900's, the pattern of urbanization closely paralleled the pattern of industrialization. Even into 1940, the boundaries between urban and rural areas were distinct, with the towns of New London, Groton, Norwich, Putnam, Willimantic, Danielson, Jewett City, Webster, and Southbridge standing out as town centers. However, population has increased in towns adjacent to these and nearby cities, in a suburban mode that has blurred the urban/rural boundary. Development continues, especially in towns bordering Long Island Sound and the Thames River. Employment in the defense and chemical industries has contributed to the consistently high growth rates in these towns. The interstate highway system reinforces development patterns through I-95, 1-86, and Highways 2 and 52. The proposed I-84, which recently received the support of both New York's and Connecticut's governors, would open up new areas when it is completed in 1990.

SOCIAL, CULTURAL AND NATURAL RESOURCES

The name "Norwich" is derived from "north" or "nor-wic" a Saxon name signifying north town. Major John Mason, Rev. James Fitch and a group from Saybrook petitioned the general court in 1659 for a charter to establish a settlement there. On August 15, 1659, the settlers acquired a deed of cession from Uncas Mohegan Sachem and his brother Wawequaw in representation of the local Indians. Included in the nine square mile cession are the present towns of Norwich, Bozrah, Franklin, Lisbon, Sprague, Preston, Jewett's City, Long Society, the western border of Griswold, and a part of Poquetannock.

In the 17th century Norwich was primarily noted for its seaport. An early trade document records "...vessels of about 30 tunn may pass up about 12 miles above New London, to or neer a town called Norwich." The first recorded date of the use of the English name "Norwich" was in March 1660. Previously it had been known as the Township of Mohegan.

The Yantic and the Shetucket rivers flow through the molded hills of southeastern Connecticut, to a point about 20 miles north of Long Island Sound, where they join to form the Thames River. The city of Norwich stands at the confluence and the towns that make up its area of influence surround it, acting in effect as a single economic entity. The area is located between two of the nation's most significant markets, New England and metroplitan New York. Access to other major markets is convenient through a complex of roadways, seaways, railways and airways.

To the east oceangoing tankers and freighters make their way up the Thames River to the turning basin formed by the conjunction of the Yantic, Shetucket and the Thames. Elsewhere within minutes of the downtown center, there are extensive quiet woodlands.

Combining urban, suburban, and rural characteristics, the Norwich area offers room for economic growth to industry, and room for spiritual, cultural, and social growth for private individuals and their families.

It was Henry Ward Beecher, the great American scholar, preacher, and abolitionist, who gave the city of Norwich its nickname. In the middle years

of the 19th century, he visited Norwich, took note of its five hills, rising sharply from the banks of the Thames River, and of its wealth, beauty, and affluence. The hills suggested to him the petals of a rose. The greens and the gardens suggested a flower's delicate beauty. He wrote a letter to a friend, in which he stated that Norwich was like a rose, and "The Rose City" it has been ever since. In fact, one of the region's most popular and famous annual events is the 12-day Rose Arts Festival which attracts people from all over New England and beyond.

Its first civic structure was a church, built high on a shelf of rock overlooking the river and the village green. From this position, the structure served as both a house of worship and a guardpost against raids by Indians. As the need for stringent measures of security declined, the town grew down the hillside to the Thames River.

By the time of the American Revolution, Norwich was the 12th largest city in the American Colonies. Its industrial and social rise was rapid. The most famous survivor of those early days is the Leffingwell Inn, dating to 1675 and still standing in the Norwichtown Historical District. Originally a stage stop on the road between Boston and New London, the Leffingwell Inn is now a preserved and restored museum, documenting the lifestyle of an earlier age.

By the turn of the 20th century there were more millionaires residing in the Norwich area than anywhere else in the New England region. The rivers provided the waterpower without which early industry could not thrive, as well as transportation of materials and finished goods to the markets of the world. Today Norwich is the seventh largest city in the State.

The Eastern Connecticut Symphony performs regularly in Norwich, as does the locally-based Norwich Concert Band.

Theater performances are provided by a number of community-theater groups. The Eugene O'Neill Theater Center, the Ivoryton Playhouse, and the Goodspeed Opera House are near neighbors.

The Slater Memorial Museum, dating to 1866, is located at Norwich Free Academy, and includes a broad collection of American and European fine and decorative arts. The Children's Museum in Norwich is a "hand-on" kind of place, where children may enhance their understanding and appreciation.

Each of the Norwich area communities has its own public library, the largest of which is Otis Library in Norwich. All are joined in formal inter-library-loan agreements extending up to the massive State library at Hartford, opening an almost unlimited collection of books, periodicals, records, and other materials to area residents.

Norwich Free Academy (NFA) is Connecticut's largest high school. Eleven buildings stand on the large and attractive campus that was founded in 1857. Philanthropist Charles F. Noyes and inventor of the Polaroid camera Edwin Land are famous NFA graduates.

The Norwich area is dotted with historic sites, many still serving as family homes. There are over 17 listings in the National Register of Historic Places clustered in Norwichtown and in the Norwich Historial District. Included is the home of Samuel Huntington, Norwich's most famous citizen. Huntington was a signer of the Declaration of Independence, President of the Continental Congress, and served as Governor of Connecticut for 10 consecutive terms. The house is now occupied by the United Workers of Norwich at 34 East Town Street.

A wharf is municipally owned and operated. Norwich is building a new 230 slip marina at the head of the Thames. Another marina, also at the head of the Thames River is privately operated.

Mohegan Park is a remarkable recreational advantage for a small city. Its 350 acres of greenery include ball diamonds, athletic courts, a tennis complex, even a Mohegan Children's Zoo where toddlers can pet and fondle tame creatures. There are State parks in and near the area, many of them wild and undeveloped; some offer facilities for camping, hiking, picnicking, and swimming.

There are public golf courses, tennis courts and playgrounds scattered everywhere in and around the area. Improvement in recreational facilities has been an integral part of area planning, and the new ball diamonds, playgrounds, tennis complexes, and basketball courts distinguish the Norwich area.

SERVICES

Water Supply - The water supply for Norwich is provided by the city of Norwich Department of Public Utilities. In 1977 the average daily consumption was approximately 5 million gallons (MG) with a peak demand of approximately 7 million gallons per day (MGD). The supply is furnished from the Deep River Reservoir in Colchester, Connecticut, which has a supply capability of 7 MGD and a storage of 1.4 billion gallons. In addition, water is furnished from a well with a capacity of 1 MG. Additional water may be made available from standby reservoirs to increase the daily supply capabilities to approximately 11.5 MGD. All of the water presently furnished to the system receives complete treatment including filtration, fluoridation, chlorination and corrosion control. The distribution system has a combined storage capability of 5.7 MG, and has recently been updated by a considerable amount of main extensions and water main cleaning projects, providing for very stable pressures in the system.

Waste Treatment - Norwich is served by a municipal sewer system. Interceptor lines are presently being completed which will serve most areas of the city. A new secondary treatment facility is also on line at this time with a capacity of 8.5 MGD average, and peak capacity of 17 MGD.

Sanitary landfill service is supplied Norwich residents by the city through contract with the owner/managers of a private facility of 30 acres. Refuse collection for the city consolidated district is a municipal responsibility; private contractors are available to provide service to other sections of Norwich.

Public Utilities - Thomas Edison built the world's first electrical generating plant in 1882, and five years later, in 1887, the city of Norwich opened its own municipal plant to provide street lighting. Today electricity is provided by the city of Norwich Department of Public Utilities (NDPU), with power primarily supplied from Connecticut Light and Power. In addition, NDPU has some generating capacity of its own for emergencies, including 3 functional hydroelectric generators producing 3 megawatts of power.

The same municipal department provides natural gas to area residents. Telephone service is provided by the Southern New England Telephone Company.

Medical - The William W. Backus Hospital, a 227 bed institution, provides a full range of services including departments of nuclear medicine, renal dialysis, physical therapy, and cardiopulmonary services. It emergency department and intensive care unit contain equipment comparable to larger city hospitals throughout the region.

The Backus Hospital also supplies medical services to the State psychiatric institution, Norwich Hospital, which is located in the area. The State also operates the 84 bed Uncas-on-Thames Hospital in the Norwich area. Uncas-on-Thames, which once specialized in the treatment of tuberculosis, has now become a center for the treatment and diagnosis of chronic diseases and for rehabilitation. In addition, there are five convalescent homes in the city, a nursing association maintained by the United Workers of Norwich, and medical laboratory services.

Education - The Norwich Public School System consists of 15 elementary schools, 2 junior high schools and the Norwich Community School serving students in grades 9-12. Norwich Free Academy, a private nonprofit institution, serves as the public high school for Norwich and a half dozen neighboring communities.

Norwich has three State educational institutions: Norwich Regional Technical School, the Thames Valley State Technical College and Mohegan Community College. Norwich is a regional center for adult education, enrolling students from New London, Groton, and Stonington as well as the Norwich area.

Transportation - Routes 52 and 2 are interstate standard highways providing excellent access to both north/south and east/west traffic. Freight service is provided by Conrail, the Central Vermont Railway and various motor common carriers. Air service is within easy reach at Trumbull Airport in Groton or Bradley Airport at Windsor Locks.

Intracity service is supplied by the Norwich Transit District with a total ridership for the year nearing 65,000.

Intercity bus passenger service is provided by: Blue Lines, Connecticut Transit, Greyhound, Savin. In addition, for industrial workers both Barstow Transportation and Savin Bus Lines offer selected shift-time commuter services to Electric Boat in Groton.

FLOODING AND FLOOD PROTECTION

Overview

Since the extent of flood damages is relative to the degree of development in the areas flooded, the early great hurricanes were not as damaging as those of the present century. As a matter of fact, the two earliest hurricanes of record in New England, which according to history must have been very severe, occurred prior to the establishment of settlements along the Connecticut coast. The recurrence of these two hurricanes under present conditions would cause extensive damages, possibly in excess of the damages sustained in September 1938.

A review of the record shows that a total of 66 hurricanes are known to have either hit or threatened the Connecticut coast since 1769. These storms have been classified with respect to their effect on the coast as indicated below:

Type "A"	-	Hurricanes causing severe tidal flooding	(9)
Type "B"	-	Hurricanes causing damage from wind and rainfall (usually accompanied by high seas and moderate tidal flooding)	(25)
Type "C"	-	Hurricanes threatening the area	(32)

In the latter case, (Type "C") a slight change in meteorological conditions could have caused any of these hurricanes to follow a course more critical to Long Island Sound, thereby subjecting the Connecticut coastal area to tidal flooding.

Forty-five of the listed hurricane experiences (A=3, B-15, C-27) have occurred during the period from 1901 to 1963, inclusive. The fact that there is a record of 45 hurricanes in this 63-year period, as compared with 21 in the 131-year period from 1770 to 1900, inclusive, is not considered indicative of a greater trend in hurricane activity in recent years but to a lack of records and information on storms prior to 1900.

Hurricane Tracks - Figure 1 tracks the hurricanes of September 1938, September 1944, August 1954 (Hurricane Carol) and of August 1955 (Hurricane Diane). These four hurricanes caused considerable tidal flooding and serious damages along the Connecticut coast.

Tidal Hydraulics

Hurricane or Storm-Tide Flood Levels - The heights of tidal flooding experienced at a number of locations along the Connecticut coastal area during Hurricane Carol, 1954, were obtained in the field and the elevation of these flood levels were determined by a field survey party and Insert 1 referred to the National Geodetic Vertical Datum (NGVD), formerly referred to as Mean Sea Level (MSL) of 1929. This information was supplemented by material on high water levels collected by the Corps of Engineers after the September 1938

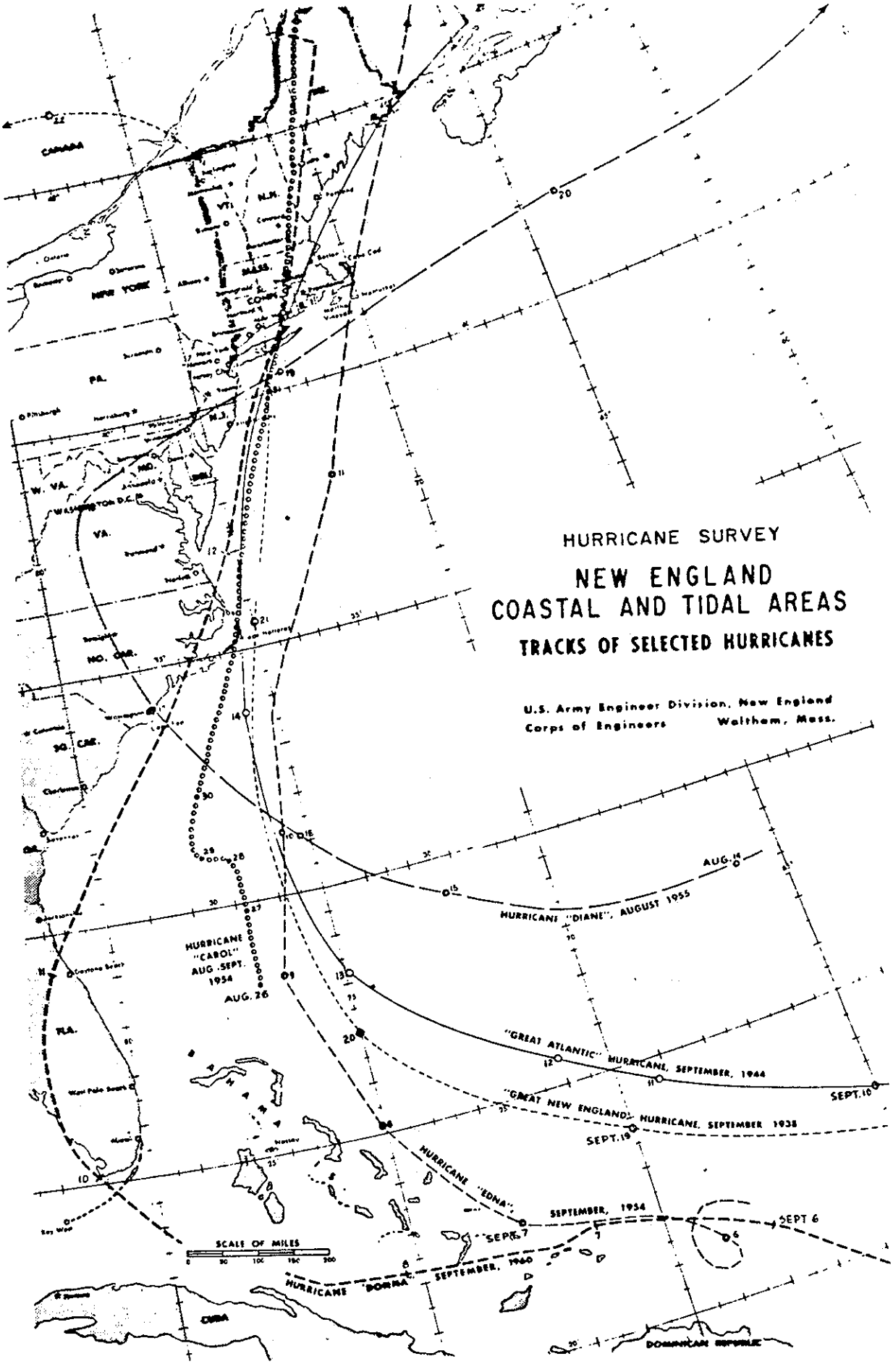
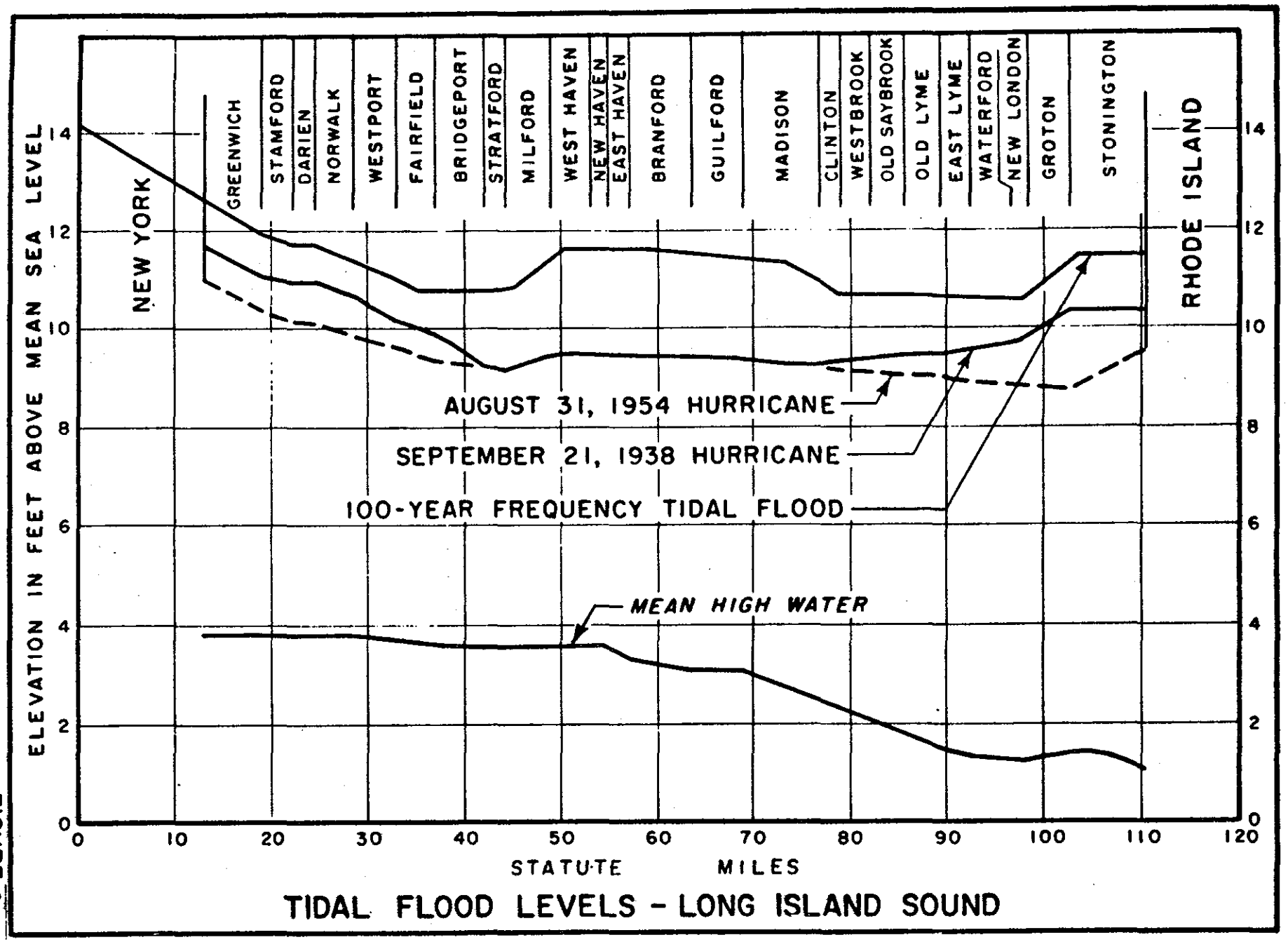

HURRICANE SURVEY
NEW ENGLAND
COASTAL AND TIDAL AREAS
TRACKS OF SELECTED HURRICANES
U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.
HURRICANE "DIANE", AUGUST 1955
AUG. 14
HURRICANE "CAROL" AUG.-SEPT. 1954
AUG. 26
"GREAT ATLANTIC" HURRICANE, SEPTEMBER, 1944
SEPT. 10
"GREAT NEW ENGLAND" HURRICANE, SEPTEMBER 1938
SEPT. 19
HURRICANE "EDNA", SEPTEMBER, 1954
SEPT. 7
SEPT. 6
HURRICANE "DORNA", SEPTEMBER, 1960
SCALE OF MILES
CANADA
NEW YORK
PA.
W. VA.
VA.
MD.
N.C.
S.C.
GA.
FLA.
CUBA
DOMINICAN REPUBLIC

Figure 1



TIDAL FLOOD LEVELS - LONG ISLAND SOUND

FIGURE 2

hurricane. Based on these data, profiles have been prepared for the 1938 and 1954 tidal-flood elevations between Willets Point, New York, at the western end of Long Island Sound, and Wareham, Massachusetts, at the eastern end of Buzzards Bay (see Figure 2 and Plate 2).

Standard Project Hurricane - The name "Standard Project Hurricane" is analogous to the "Standard Project Storm," defined by the Corps of Engineers for a particular drainage basin and season of year as "...the most severe storm that is considered reasonably characteristic of the region in which the basin is located." Like the Standard Project Storm precipitation, the SPH index is based on enveloping the records of meteorological events with elimination of a few extreme events. The 1944 hurricane was established as the Standard Project Hurricane. This hurricane had the greatest amount of energy of any recorded storm along the Atlantic Coast when it was off Cape Hatteras, North Carolina. This SPH was established with the cooperation of the U.S. Weather Bureau and the Coastal Engineering Research Center (formerly the Beach Erosion Board) assisted by the Texas Agricultural and Mechanical Research Foundation.

The SPH was transposed over an ocean point between Cape Hatteras and the New England coast to simulate the maximum surges along the Connecticut shoreline of Long Island Sound. The transposed hurricane was assumed to advance in a due northerly direction at forward speeds of 40 and 30 knots (about 46 and 34 mph)., with its center crossing the New England coast at a point 49 nautical miles (56 statute miles) west of Montauk Point, Long Island, near the eastern entrance to Long Island Sound. This storm track placed the most critical area of the hurricane at the entrance to the Sound. The maximum surge, at the eastern end of Long Island Sound, has been determined to be 13.4 feet. Routing this up the Sound give surges from 9.0 to about 13.0 feet at various locations along the Sound. Adding the surges to the mean spring tide has been designated as the Standard Project Hurricane Flood Level (SPHFL).

Past Flooding

Since the eastern entrance of Long Island Sound lies in the path of hurricanes moving into New England from the south, the Connecticut coastline along the north shore of the Sound has frequently been subject to tidal flooding from hurricane surges moving west through the Sound. Records indicate that the Connecticut coast has experienced or has been threatened by hurricane tidal flooding upon 66 occasions since 1769. However, the greater number of these, due to the direction of their paths, did not cause tidal flooding along the Connecticut shore.

Nine hurricanes, though, did cause severe tidal flooding. In their decreasing order of magnitude, as far as can be determined from existing records, the five greatest of the nine hurricanes causing severe tidal flooding have been those of 21 September 1938, 24 August 1893, 31 August 1954, 15 September 1815, and 14 September 1944.

In recent years the hurricanes that caused tidal flooding along the coasts of Rhode Island and southern Massachusetts have also caused flooding along the Connecticut coast. But there are no available records to indicate if storms

prior to 1640 affected the then relatively undeveloped Connecticut shore along Long Island Sound. It is reasonable to presume, though, that the severe storms of 15 August 1635 and 3 August 1638 and three others prior to 1770, did cause some lowland flooding along the Connecticut coast since extensive tidal flooding was recorded in Massachusetts and Rhode Island.

The most severe flooding in Norwich occurs when hurricanes or coastal storms, with their intense winds and rainfall, create abnormally high tidal surges, wave runup and peak runoff. Snowmelts and Icejams only compound the spring and winter coastal storm flooding. All of these combined effects are at a maximum when the storm track is west of Norwich. The flood of record for Norwich is the 21 September 1938 "Great New England" hurricane and the second-most flood of record is the 1954 Hurricane Carol.

In 1975 it was estimated that $1.22 million average annual coastal flooding damages occur among New London, Montville and Norwich (NERBC, LISS, 1975). The New London damages alone far exceed the combined inland riverine damages. Figure 3 indicates this comparative severity of damage centers.

Potential Flooding

The tidal flood levels and losses in recurring hurricanes of the 1938 and 1954 magnitudes would be:

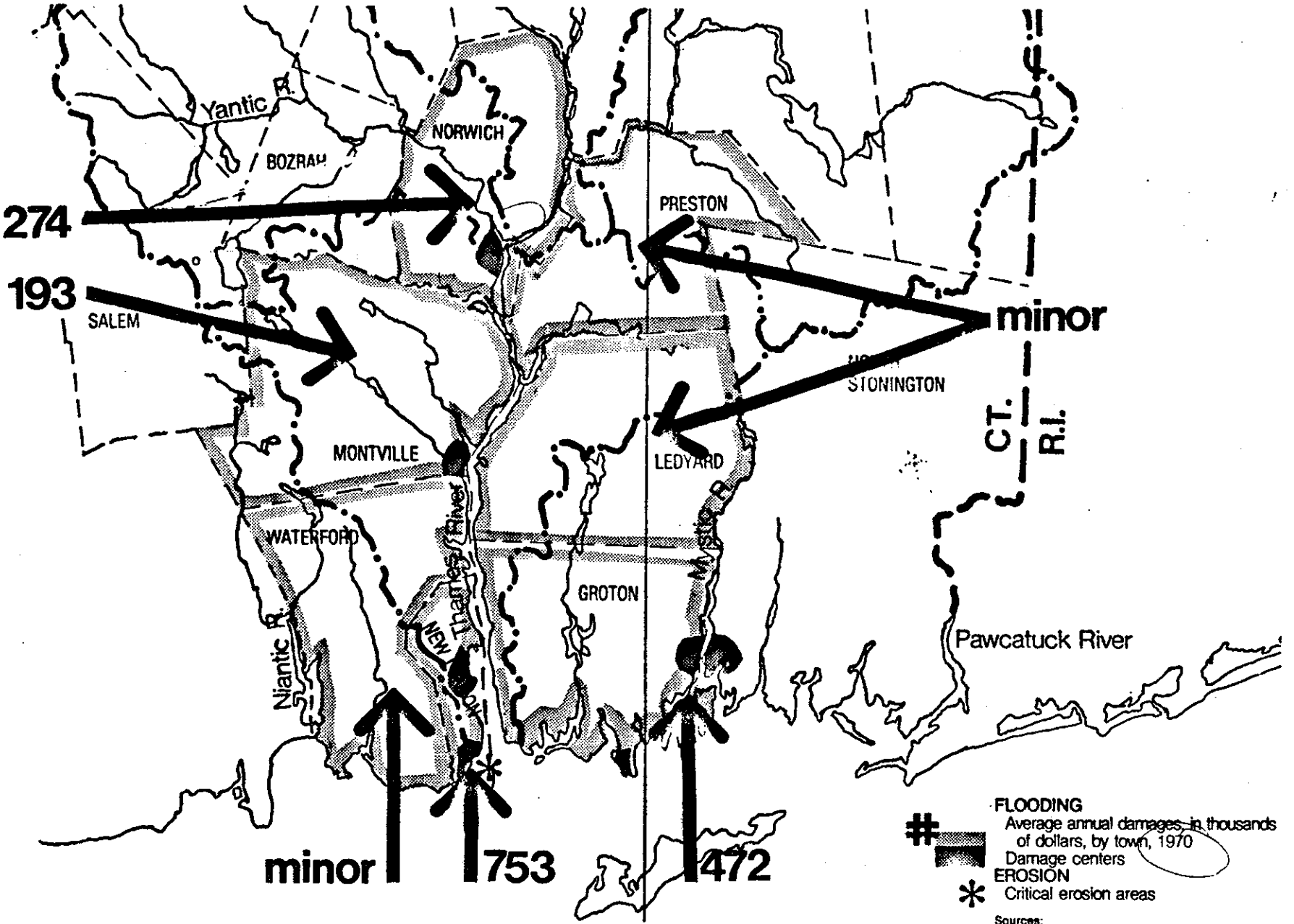
Hurricane	Stages (south to north)	Recurring Loss (1975 P.L)
1938	13.7 to 15.1 (NGVD)	$11,300,000
1954	10.1 to 10.6 (NGVD)	3,600,000

. SPH Flooding - Norwich's tidal shoreline along the west bank of the Thames River, below the junction of the Yantic and Shetucket Rivers, is about 2.7 miles long, and the east bank is about 3.4 miles long; a total shoreline of 6.1 miles. The SPH flooding would be experienced to stages from about 20.0 to 22.0 feet NGVD, south to north. The major concentration of damages would be at Thamesville, an industrial area on the west bank of the river. In this low lying area there are about 42 structures vulnerable to tidal flooding. Damages would start at about elevation 7.00 NGVD. With the SPH still water level (SWL) at 20.7 NGVD, about five feet higher than the flood of record, the damages would be enormous.

. 100 Year Flooding - The 100-year flood at elevation 13.4 NGVD would also create major damages. The 1954 hurricane was close to the 100-year flood. The 10-year and 50-year floods have elevations of 8.7 and 11.9 NGVD (as noted earlier). The flood damage in this area starts at about elevation 7.0 (see Figure 4).

Existing Flood Protection Measures

Between 1952 and 1965, the Corps of Engineers constructed six flood control reservoirs in the Thames River basin. These reservoirs control runoff from the upper watersheds of the Shetucket and Quinebaug Rivers above Norwich. Out of general plans to alleviate high tidal flood damage along the New England/ New York State coastline came the New London Harbor Hurricane Barrier, now



Coastal Flooding Damages

Fig. 2 3

46 8003

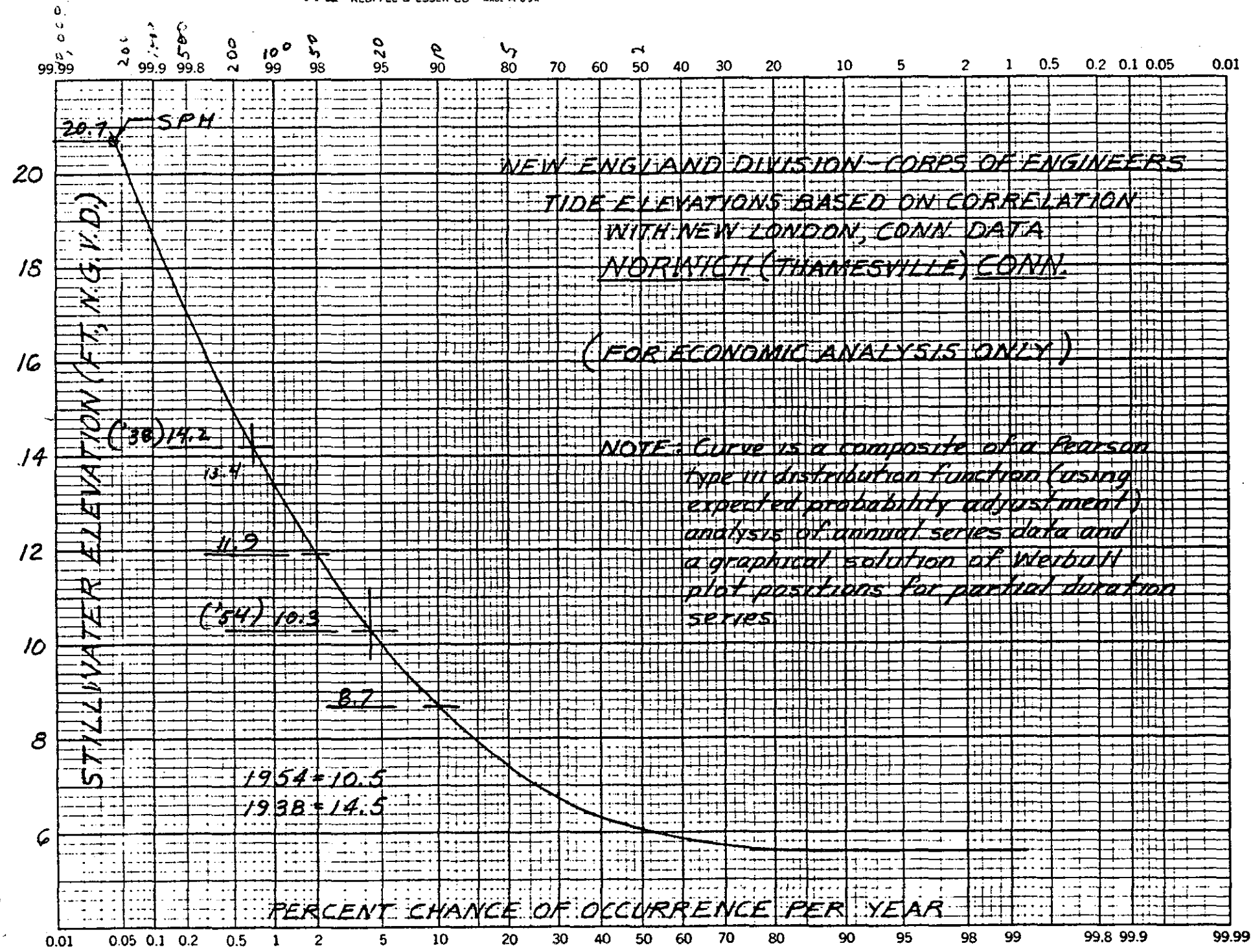


FIG. 4

under construction. In Norwich structural and non-structural measures are providing some control of flood damage. In Norwich several small reservoirs are providing moderate control of upland runoff. Two such reservoirs were constructed by the Soil Conservation Service in 1963 and 1964 on Spaulding Pond Brook.

The Shetucket River Channel Improvement Project was completed in January 1959 by the Corps of Engineers. In conjunction with regular navigational dredging on the Thames River, the rock excavation and the raising of the Laurel Avenue Bridge have significantly increased the flood carrying capacity of the lower Shetucket River.

State Channel Encroachment Lines have been adopted along part of the Shetucket River in Norwich to restrict building in potentially hazardous areas. The City Council has also adopted a map prepared by the Inland Wetlands Commission which restricts building in any areas shown on the map as wetlands.

Presently Norwich participates in the National Flood Insurance Program (NFIP) which leads to local programs for controlling growth within the flood plains. Communities declining to participate become ineligible for any Federal expenditures within a flood prone area, and owners of property within the flood plains would be unable to obtain financing from Federally insured lending institutions.

Norwich, controlling growth within their flood plains, meets the minimum requirements of the ongoing NFIP. The NFIP provides a Federal subsidy to private insurers so that flood prone properties may be eligible for flood insurance ($245,000 limit for single family residence and contents, $550,000 for small business structures and contents, and $400,000 limit for other nonresidential property and contents).

Regulatory measures discourage the use and development of the flood plains, thus lessening the threat of flood damage and possible loss of life.

Flood plain regulations help avoid repetition of past building errors by preventing additional construction on already developed flood plains. Communities may adopt more stringent regulations than those required by the National Flood Insurance Program. Such restrictions require the enactment of ordinances to implement and enforce land use planning programs involving the delineation of flood hazard areas.

Enroachment lines drawn on the map on each side of a watercourse show the lateral limits within which development must be restricted in order to preserve the flood carrying capacity of the river and prevent further growth in the flood plain. Figure 5 is a schematic drawing of the concept. The central portion, or floodway, consists of the river channel and that portion of the adjoining flood plain required to pass a 100-year flood. No construction or filling should be allowed there, although parking lots, recreation, agriculture, and other nonstructural uses may be permitted, provided that the free flowing state of the floodway is not impaired.

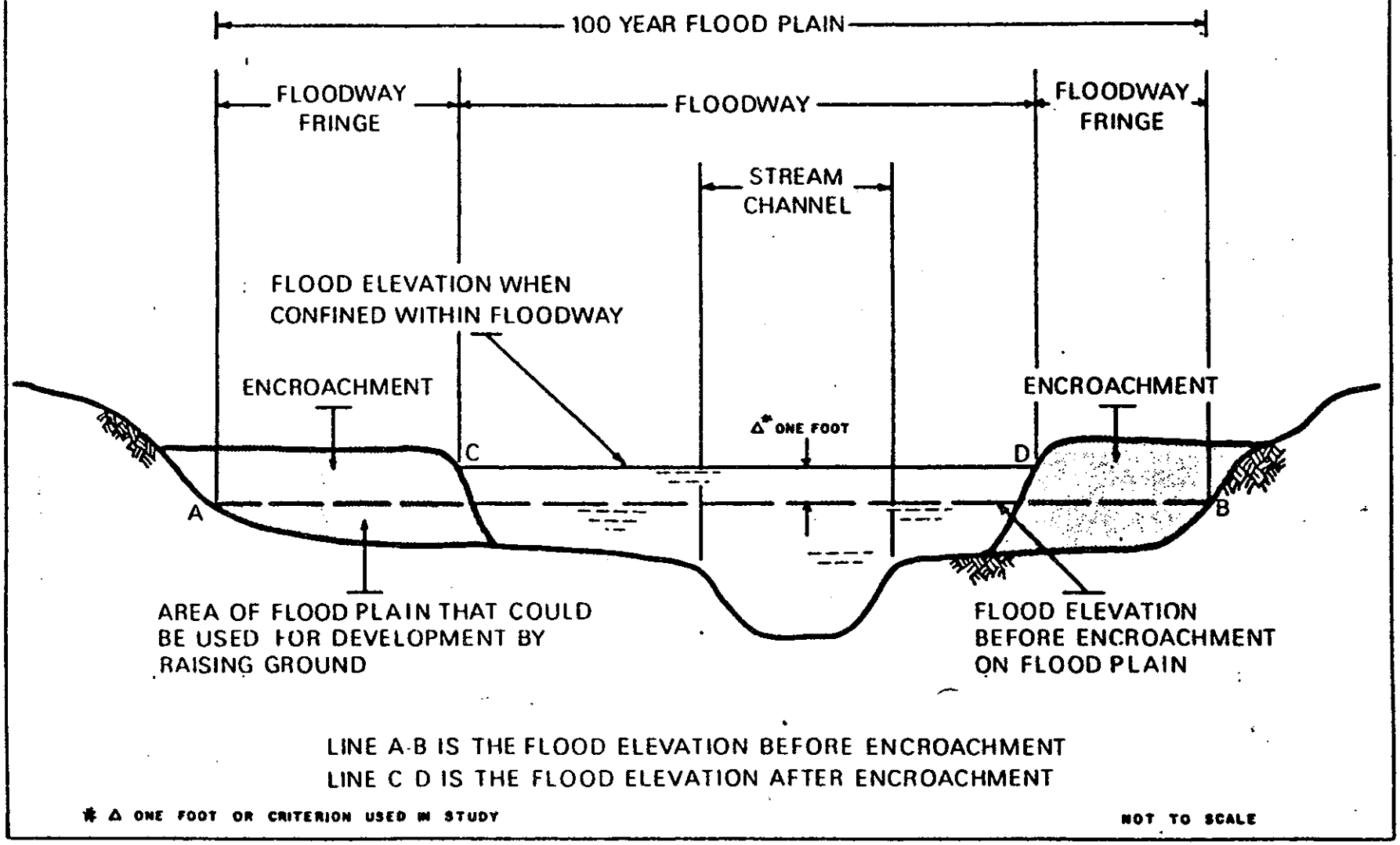


FIG. 5

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

FLOODWAY SCHEMATIC

The floodway fringe is the remainder of the 100-year flood plain. Limited encroachment or filling may be allowed here, providing it does not cause the water level of the 100-year flood to rise more than one foot (or less if so established by State or local regulations). Any construction here must be floodproofed to the 100-year flood level.

PRIOR STUDIES AND REPORTS

A number of prior studies and reports which were prepared by the U.S. Army Corps of Engineers and other Federal agencies have been utilized in the preparation of this report.

"308" Report - a report dated 1 December 1930 and printed as House document 644, 71st Congress, 3d session, covered navigation, flood control, power development and irrigation in the Thames River basin. The report found that further improvements were not warranted at that time.

1940 Report - A preliminary examination, survey and review of reports on the Thames River for flood control and other purposes, dated 11 April 1940 was printed as House Document 885, 76th Congress, 3d session. The report recommended construction of one local channel improvement project at Norwich, Connecticut and seven flood control reservoirs: Hodges Village, Buffumville, East Brimfield, Westville, Mansfield Hollow, Andover and South Coventry. The plan was authorized by Public Law 228, 77th Congress, 1st session, approved 18 August 1941.

NENYIAC Report - Flood control in the Thames River basin is also considered in Part Two, Chapter XX of "The Resources of the New England-New York Region," a comprehensive report on power potentialities and on the land, water, and related natural resources of the region. Prepared by the New England-New York Interagency committee (NENYIAC), the report was submitted to the President of the United States by the Secretary of the Army on 27 April 1956. This report is printed as Senate Document 14, 85th Congress, 1st session.

In 1971, the U. S. Water Resources Council designated the New England River Basin's Commission to conduct a comprehensive water resources study of the Long Island Sound area in conjunction with the State of Connecticut, the State of New York and several Federal agencies. As a result of this study a number of reports entitled; Land Use, Water Management, Shoreline Appearance and Design, Erosion and Sedimentation, Flood Damage Reduction, Recreation, Fish and Wildlife, Marine Transportation, Mineral, and Power and the Environment were prepared by various Federal agencies. Information contained in those reports has been utilized in developing this report.

Additional reports used are listed as follows:

"Shore Protection Manual," Volumes I, II and III dated 1973, prepared by the U.S. Army Corps of Engineers, Coastal Engineering Research Center.

"Long Island Sound Regional Study Land Use Inventory Report" dated February 1974 prepared for the U.S. Department of Housing and Urban Development by Ralph M. Field and Associates.

Long Island Sound Interim Memo No. COE 2 "Tidal Hydrology" dated June 1973, prepared by the U.S. Army Corps of Engineers, New England Division.

People and the Sound "Flood Damage Reduction" dated 1975, prepared by the U.S. Department of the Army, Corps of Engineers; and the U.S. Department of Agriculture, Soil Conservation Service.

People and the Sound "Erosion and Sedimentation" dated January 1975, prepared by the U.S. Department of the Army, Corps of Engineers; and the U.S. Department of Agriculture, Soil Conservation Service.

Long Island Sound Regional Study "An Economic Perspective, A Special Report," dated July 1974, prepared by The Economic and Demographic Work Group of the Long Island Sound Regional Study.

Hurricane Survey Interim Report "Connecticut Coastal and Tidal Areas" dated 22 May 1964, prepared by the U.S. Army Corps of Engineers, New England Division.

SECTION III

THE STUDY

THE STUDY

This section provides an outline of the study's planning process and presents a general discussion of the major work items that will be considered along with a schedule projecting their completion. As noted earlier, this study is undertaken directly as a result of a recommendation of the 1975 Long Island Sound Regional Study (LISS), which recommended that the Corps study alternate ways of protecting lives and property in seven tidal-flood prone areas. The first of these is the Thamesville section of Norwich, Connecticut. Based on the LISS recommendation and in response to the problems and concerns identified previously, this study focuses primarily on flood control and tidal flood plain management. Analyses will be assembled into four principal effort components, grouping discrete work tasks to facilitate study management and comparability.

PLANNING OBJECTIVES

General

The Corps of Engineers seeks plans which not only provide solutions for existing flood problems but also offer the potential to reduce future flood damage within the study area. Water resource planning conducted by the Corps must be consistent with national aims of developing through public involvement, plans which serve the purpose of solving local and regional flood problems in conjunction with other urban planning programs (see Table 1).

National Objectives

Water resources planning undertaken by Federal agencies is directed by the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources. These principles provide the basis for Federal participation with river basin commissions, State agencies and other concerned groups in developing plans for the use of water and related land resources to meet short and long term needs. Plans will, therefore, be developed in the interest of achieving the goals of enhancing national economic development (NED) and national environmental quality (EQ). Economic development is enhanced by increasing the value of the Nation's output of goods and services and by improving national economic efficiency. The quality of the environment is enhanced by the improved management, conservation, preservation, creation or restoration of certain natural and cultural resources and ecological systems.

In addition, Section 73 of the Water Resources Development Act of 1974 mandates: "(a) In the survey, planning or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages including, but not limited to, floodproofing of structures; flood plain regulation; acquisition of flood plain lands for recreational, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially and environmentally acceptable means of reducing or preventing flood damages."

TABLE 1

PLANNING OBJECTIVES

PLANS TO BE CONSIDERED

1. SCHEMES FOR NONSTRUCTURAL FLOOD CONTROL PLAN

    1. Flood Plain Management, Warning and Evacuation
    2. Flood Plain Relocation, Existing Structures in 100-Year Flood Plain
    3. Floodproofing of Structures, Existing Structures in 100-Year Flood Plain
    4. Raising Existing Structures
    5. Removal of Existing Structures and/or Contents from a Flood Hazard Area
    6. Zoning Ordinances, Subdivision Regulations, and Building and Housing Codes
    7. Public Acquisition of Flood Plain Land

II. SCHEMES FOR STRUCTURAL FLOOD CONTROL PLAN

    1. Land Treatment Measures
    2. Reservoirs
    3. Walls and Dikes
    4. Stream Improvements
    5. Hurricane Barriers

State Objectives

A variety of comprehensive plans and programs have a direct bearing on water and related land uses in the basin. Since they are relevant to this study, they are described here and only briefly referenced.

Connecticut Conservation and Development Policies Plan - Two plans of conservation and development have been completed--one in 1974 and an updated and broadened revision of this for adoption in 1979. The more recent plan establishes goals, policies, and priority actions to guide state programs in such areas as housing, energy, economic development, land and water resources, and water supply. A land classification system provides the basis for more location-specific strategies. After adoption by the General Assembly, the plan will be implemented by the Office of Policy and Management. The office will review state agency investments and programs for conformity with plan policies.

The Connecticut Long Range Water Resources Management Plan (LRWRMP)- In 1967, Section 25-5b of the Connecticut General Statutes authorized the development of a LRWRMP to identify water demands and assess supplies, to recommend water resource management plans, and to coordinate water supply and sewerage plans. Planning responsibilities were assigned to an Interagency Water Resources Planning Board, composed of the Department of Environmental Protection, the Department of Health, and what is now the Office of Policy and Management. The Phase I report was completed in 1971, its water resource management policies are reflected in the 1974 state Plan of Conservation and Development. Later legislation provided for a continuing planning process rather than a single document. Current efforts are conducted by the Department of Environmental Protection, Natural Resources Center, using funds from Title III of the 1965 Water Resources Planning Act and on behalf of the Interagency Water Resources Planning Board. A key concept of the Center's approach is the basin budget analysis. For each approximately 20 square mile drainage area into which the state has been divided, a characterization of water and related land resources, water use demands (such as water supply, navigation, wetland habitats, flood management), problems and conflicts, and program needs are being analyzed. Included in the program as a cooperative effort with United States Geological Survey (USGS) is an evaluation of the resource monitoring network needed for decision-making, which will eventually provide the basis for a Comprehensive Integrated Modeling and Monitoring system.

Connecticut Coastal Area Management Program - In 1978, after three years of coastal area planning by the Department of Environmental Protection, legislation to establish a coastal area management program was submitted to the Connecticut General Assembly. The legislature passed an abridged version (PA 78-152) and established a committee to study the program. The committee is now reviewing a redrafted bill.

Intended to provide better coordinated and more uniform decisions over coastal resources, the bill defines a series of goals and policies under which the state and coastal municipalities would carry out their responsibilities. The primary goal is to insure that development, preservation or use of coastal land and water resources is consistent with their capability to support these uses without significant disruption of the natural environment or sound economic growth. This and more detailed policies would apply to a coastal area boundary defined by the 100-year flood hazard area, land within 1,000 feet of mean high water, or land within 1,000 feet of a tidal wetland, whichever is greatest.

Under the existing bill and proposed amendments, coastal municipalities would develop management programs and institute site plan review procedures for uses and resources within the coastal area. The State Department of Environmental Protection would conduct planning and regulatory programs in accordance with coastal policies, approve local plans and provide financial and technical assistance, and administer Federal coastal zone funds.

Eastern Connecticut Resource Conservation and Development Project - The RC&D program in the basin was established in 1967 under the authorization of the U.S. Food and Agriculture Act of 1962. Its purpose is to coordinate local, State, and Federal agencies in planning and carrying out conservation and evelopment projects relating to flood prevention, fish and wildlife, water-based recreation, erosion, and agricultural pollution. The program is sponsored by the Connecticut Department of Environmental Protection and administered by the Soil Conservation Service, U.S. Department of Agriculture. Activities proposed by towns, the state, or a nonprofit organization are reviewed by the RC&D executive council, consisting of representatives from the participating Soil and Water Conservation Districts, Regional Planning Agencies, and at-large members appointed by the Department of Environmental Protection. Project funding is provided through the many different programs of the U.S. Department of Agriculture and directly through the RC&D Program.

Specific Planning Objectives

Two specific planning objectives have been identified:

- reduce potential tidal flood damage at the Thamesville area of Norwich, Connecticut.

- evaluate various combinations of nonstructural and structural flood damage reduction techniques for possible adoption in programs and policies for tidal flood plain management throughout the coastal area.

Other issues have been or are currently being investigated through other means. This study will complement other planning efforts, not duplicate them. Other water and land resources will be considered in the alternative flood plain management plans wherever possible.

These objectives were compiled from meetings with State, regional and local officials. They are based upon information collected to date. More definitive planning objectives will emerge as the study progresses and is refined. These will be incorporated into the interactive planning process.

Study Tasks

In development of a tidal-flood damage reduction plan, study tasks will:

- Address specific tidal-flood problems and issues and those concerns identified by the public;
- Be flexible to accommodate changing economic, social and environmental patterns and technologies;
- Integrate with, and be complementary to, other urban development and management programs;
- Be fully coordinated with affected public agencies at all levels;
- Be developed through an orderly, structured and open planning process;
- Be capable of implementation, with respect to financial and institutional capabilities and public consensus; and
- Where appropriate, be approved by applicable State and Federal agencies.

In order to meet the goal and the objective of this study, the planning process will consist of the following:

- The development of a series of alternative tidal-flood plain management plans to meet future needs, from which a choice may be made prior to completion of the study;
- An evaluation of that portion of each alternative designed to meet immediate needs;
- An early action program for each alternative plan which will meet immediate needs; and
- Where appropriate, a proposal for congressional authorization of selected elements of the early action program of the publicly selected "best" plan, when these selected elements are traditional Federal responsibilities.

PUBLIC INVOLVEMENT STRATEGY

General

A vital part of an effective planning process is public participation. The development and subsequent implementation of sound flood plain management plans is keyed to how effectively the public has been involved in all phases of the study progress. Such participation assists planners in defining study objectives and priorities and develops channels through which ideas and information can be shared by all participants.

In the broadest sense, the public consists of all non-Corps of Engineers entities: Federal, State, local and regional agencies as well as public and private organizations and the general public. Initial identification of the public has been made during the preparation of this Reconnaissance Report and may generall be categorized into three destinct, yet related, groups consisting of the governmental sector, special interest groups and the general public.

The primary objective of the public participation program is to provide continuous two-way communication to involve the public in the overall planning process. By keeping the public informed about the study's progress, interested persons can assist in the making of decisions which would affect those who live in the study area. Inasmuch as major decisions made thorughout the study will be based upon the expressed needs and objectives of all local, county, State and regional officials and members of the general public, it is necessary to establish a mechanism to channel information concerning the study to interested participants and to relay their responses to those conducting the study.

Objectives

These objectives have been established to develop a planned program to insure the public's interests and desires are considered and acted upon:

. Present information which will assist the public in the definition of water and related land resources problems within the study area and the concerns, objectives and priorities of its citizens so they may effectively participate in the study.

. Foster an understanding among study participants in which free exchange of ideas is possible and develop channels through which public concerns, preferences and priorities will be heard and considered.

. Develop a structure to give the public an opportunity to influence the formulation and evaluation of planning alternatives. to identify and resolve conflicts where they may arise and to achieve consensus on all study courses of action.

. Establish a control system which is flexible and can be modified in response to the study needs as they are identified.

. Establish a system of coordination between this study and water resources planning efforts of other Federal, State, regional and local agencies.

Public Involvement Interactions

Implementation of the public involvement program will occur during each stage of the study. The program will occur during each stage of the study. The program is structured to provide the public with a better understanding of the entire planning process as the study progresses from one stage to the next. The preparation of this Reconnaissance Report (Stage I), Development of Intermediate Plans (Stage II), and Development of Final Plans (Stage III) requires the iteration of planning activities at successively greater levels of detail, effort and refinement. Each stage will be conducted by carrying out the four functional planning tasks of problem identification, formulation of alternatives, impact assessment and evaluation during plan development.

The public involvement program for each of these tasks will be conducted generally as follows:

a. Problem Identification

During the problem identification, public involvement efforts will be programmed to:

. Inform the general public and specific publics about the study effort being undertaken.

. Obtain data which will assist in the identification and description of tidal flood plain management problems, concerns and opportunities.

. Obtain an indication of the relative priority of planning objectives from a public point of view.

. Solicit information concerning the public's environmental, social, and economic desires.

. Obtain public review and reaction to the results of problem identification.

Specific work tasks will include:

. Preparation of a list of "publics" to be contacted.

. Preparation of an information fact sheet and other study announcements and brochures.

. Preparation of materials for workshops, seminars, interviews and speaking engagements.

. Prepartion of a list of repositories for study documents.

. Analysis of feedback.

. Evaluation of the effectiveness of the public involvement program.

Implementation mechanisms to be used during problem identification include mailings and media presentations, briefings of officials and leaders and public meetings.

b. Formulation of Alternatives

Public involvement will aid in assuring that the alternatives developed address the full range of problems and concerns as perceived by the public in response to stated planning objectives. Specific public involvement objectives during this phase will include:

. Inform the public and obtain their feedback about the various technological and managerial measures available for meeting stated objectives.

. Obtain public review of and reaction to alternative measures and plans. Specific work tasks to be accomplished during the formulation of alternatives will include preparation of materials, including brochures on alternative programs; preparation for workshops and public meetings; dissemination and preparation of materials to identified publics; and analysis and evaluation of the program.

Implementation mechanisms to be utilized during this phase of the planning endeavor will include presentations to various groups and organizations, the information fact sheet, workshops, public meetings, and information meetings.

c. Impact Assessment

Public involvement during impact assessment will focus on identification and measurement of the impacts of water resources plans as they relate to the entire study area and the general public. Substantial public involvement will be utilized so that the public will understand each alternative plan and its impacts. Major objectives of public involvement during the impact assessment phase are to:

. Obtain information about interest groups, primarily those concerned with each class of impacts in order to identify those groups and individuals to be specifically consulted during evaluation.

. Describe the elements and impacts of each alternative plan and obtain public input on the significance of impacts to each affected interested group.

. Obtain additional input for each succeeding iteration.

Work tasks to be accomplished include the preparation of materials describing concepts used in impact assessment, dissemination of materials on impact alternatives, solicitation and recording of reactions and preferences concerning impact of alternatives and interpretation of public reation.

In the assessment phase, brochures displaying the impact of the various alternatives, oral presentation to interested groups and public forums will be used.

d. Evaluation

Specific public involvement objectives during the evaluation of alternative plans will include:

. Obtain public input concerning the acceptability of alternative plans.

. Rank alternatives in terms of their contribution to planning objectives and public acceptability.

. Allow publics to discuss disagreements, if any, with a goal of arriving at a mutially agreeable solution.

. Summarize information on the evaluation of alternative plans.

In addition to formal public meetings, both progress and informational meetings will be held to maintain close cooperation of study elements with all study participants. The progress-type meetings would be a working session of the advisory group, consisting of study members and representatives of State and regional water resource planning agencies as well as interested members of other publics. These meetings will be held when significant points in study effort have been achieved. Such procedure will afford study participants an opportunity to discuss the study, focus attention on specific problem areas and analyze the legal and institutional framework that will be required for plan implementation. It will also provide a means of ready access to additional study materials as needed.

Information or workshop meetings will primarily consist of two types. The first type will be with public groups to provide a combination of public information and interaction. The second type will be conducted at the request of any small group from all sectors of the public. These meetings would provide a ready source of information regarding specifics as well as more study exposure.

Work tasks to be undertaken include preparation of materials dealing with the overall objective of program analysis and the concept of trade-off analysis, presentation and display of plans, final impact comparisons, program and systems, solicitation and documentation of reactions and preferences, interpretation of public reaction, and meeting with publics to establish final decisions on plans and programs.

Implementation mechanisms will include centrally located information depositories, progress meetings, information meetings, workshops and public meetings.

e. Public Meeting Schedule

During the course of the study, there will be areawide public meetings held where the public can officially participate, ask questions and express their opinions.

The format for the public meetings will consist of a presentation by the Corps of Engineers. These presentations will then be opened to public discussion and the study team will respond to questions from the public. The public meetings will be as follows: an Initial Public Meeting, if found necessary, to be held at the conclusion of Stage I; a Plan Formulation Public Meeting, at the end of Stage II, and Late Stage Public Meeting at the completion of detailed study.

f. Coordination

The public involvement program proposed for the Thamesville Tidal-Flood Management Study will be closely coordinated with other water resources planning efforts being conducted by local, regional, State and Federal agencies. The Corps will have responsibility for conducting the public involvement activities in cooperation with the State of Connecticut.

INSTITUTIONAL ARRANGEMENTS

General

The intent of this study is to provide tidal-flood plain management plans that are compatible with comprehensive urban development goals. To this end, this study will develop alternative tidal-flood plain management plans from which one may be selected for implementation.

By definition, an "institution" is a process or organization that is highly structured, systematized, and stable. Institutional structures may, therefore, be organizations such as planning agencies, water commissions, sewer boards, or special interest groups; or they may be formalized practices or procedures such as home rule, tax structures or financial obligations. "Institutional analysis" is a process whereby institutions, directly or indirectly related to water resources planning and management, are identifed and their capability to implement alternative plans is assessed. "Institutional arrangements" are those tasks or procedures which suggest how existing institutional structures should be utilized, or modified, new institutions created, or existing institutions abandoned in order to facilitate implementation of the plan.

Analysis Procedures

To insure that each alternative developed in the study is indeed implementable, a thorough analysis of the institutional structure required for such implementation must be undertaken.

This study will define certain problems or issued within the study area and develop technical alternatives for solutions to those problems. Institutional arrangements designed specifically to implement the alternatives will then be recommended. Specific tasks to be undertaken in the institutional analysis are:

a. Establishment of an institutional data base, including an inventory of existing agencies and agency types.

b. Analysis and evaluation of institutional capabilities to implement the tidal-flood plain management plans developed in the study, including organizational information, scope of operation, financial strength and capacity, jurisdiction, and relationship with public interest groups and other agencies.

c. Development, presentation, analysis and evaluation of alternative institutional arrangements and implementation strategies.

Such analysis parallels the overall planning process, moving from broad collection to specification of detailed institutional arrangements for implementation of the tidal-flood plain management alternatives. Assessment of existing institutional capability to implement the alternative plans and recommendations for modifications, to make such institutions more effective, will naturally follow.

The analysis conducted as part of this study will concentrate on those institutional structures directly associated with the problem. Overall, institutional analysis will focus on the organizational and financial analysis of government agencies, primarily at the local leve, as alternative tidal-flood plain management plans in the study area may be a predominantly local government responsibility.

Existing Institutions and Trends

Although Federal and interstate government agencies perform various fucntions it is State and local governments that share the major responsibility for water resources planning, regulation, technical and financial assistance, and policy development. Primarily the State and local government agencies provide the framework for existing institutional structures.

As is typical of the rest of New England, the study area is characterized by a tradition of strong local involvement in all resource decision making. Special interest organizations such as citizen groups also play a vital role in influencing decision making. The following list identifies, in addition to the Corps of Engineers, some of the institutions that have a significant interest in water resources management within the Thames Estuary.

Federal Agencies

U.S. Geological Survey, Water Resources Division (USGS) - The overall objectives of the U.S. Geological Survey are to conduct surveys, investigations and research covering topography, geology, and the mineral and water resources of the United States. The agency is responsible for coordinating all data by Federal agencies having to do with water resources. To facilitate this task, the USGS maintains catalogs and maps of water related information which are useful as a basis for planning.

U.S. Department of Agriculture, Soil Conservation Service (SCS) - The Soil Conservation Service directs field operations in the study area and provides technical assistance in the development, application and maintenance of oil and water conservation lands through local soil conservation districts. The agency is authorized to assist local governments with planning and financing watershed conservation projects and other flood prevention measures. These programs provide assistance in projects that promote the conservation, development and use of water and the prevention of soil erosion.

U.S. Environmental Protection Agency (EPA) - The Environmental Protection Agency is responsible for the control of air and water pollution, drinking water quality, solid wastes, pesticides, environmental radiation and noise. Through the legislation contained in PL 92-500, the agency establishes deadlines for clean waters, a system of permits and licenses, water quality standards, a system of user charges and areawide planning. The agency also provides funding and enforcement powers to eliminate the discharge of pollutants into the Nation's waters. Congress has authorized EPA to provide State grants for research and development, manpower training, water quality planning, monitoring and enforcement.

U.S. Department of Housing and Urban Development (HUD) - Under the provisions of Section 701 of the National Housing Act of 1954, as amended, this agency is involved with State and local governments in planning and developing solutions to housing problems, mass transportation, water supply, water quality management, runoff control and related problems.

U.S. Army Corps of Engineers, New England Division (CE/NED) - The Corps of Engineers involvement with water resources includes navigation improvements, streambank and shore erosion control measures, flood control works, reporting on streams, shores and flood plains and providing flood plain management services. A substantial part of the Corps work is in related areas such as provision for water supply, hydroelectric power generation, stream regulation, and water based recreation. Recent duties include the administration of laws to preserve important wetlands and navigable waters and their environmental quality. In keeping with the need to enhance the environment's quality and productivity, the Corps has also been charged with developing comprehensive plans for the conservation and efficient use of vital water and related land resources.

Federal Emergency Management Agency, Federal Insurance Administration (FEMA/FIA) - The National Emergency Management Agency - formerly the Department of Housing and Urban Development, Flood Insurance Administration. The program provides local officials with a usable tool in protection of their flood plains. A flood prone community, once on the regular program, must enact flood plain zoning in accordance with minimum guidelines established by FEMA. Failure to enact or enforce such legislation could be penalized by forfeiture of all Federal funding assistance.

A product of the program is the Flood Insurance Study (FIS). These include compilation of stream profiles, delineation of flood plains, and flood hazard analyses.

U.S. Department of the Interior, Fish and Wildlife Service (USFWS) - The primary goal of this agency is the conservation and enhancement of fish and wildlife resources. Major activities for the conservation of fish and wildlife include the acquisition and management of national wildlife refuges, and the operation of fish breeding, distribution and restoration programs. Other activities include the protection of critical habitats, the enforcement of Federal law protecting wildlife and management of game birds, and consultation with other Federal agencies engaged in water development projects.

Interstate Agencies

The New England Governors conference which is composed of the six New England governors, exists to coordinate State activities with regard to natural resources. A Federal Regional Council, too, has been established for the New England region. This council is to improve the administration of Federal grant programs in the region by improving program operations, developing funding programs in cooperation with State and local officials, and encouraging joing and complementary grant applications. Finally, other special-purpose organizations such as the New England Interstate Water Pollution Control Commission exist to coordinate specific functional activities in the region.

New England River Basins Commission (NERBC) - The Commission, a Federal-State planning organization established under the authority of the Water Resources Planning Act of 1965, is composed of the six New England States and New York, ten Federal agencies, and six other interstate regional agencies concerned with water pollution and flood control. NERBC has three statutory responsibilities: to coordinate water and related land resources plans throughout the region, to prepare and update plans for managing the region's water and related land resources, and to recommend priorities for the collection of natural resource data, solutions to resource management problems and implementation schedules.

State of Connecticut

Responsibility for water resources is vested in two State departments and one interagency board. The responsibility for enforcement of various statutes rests primarily with the Departments of Health and Environmental Protection.

Department of Environmental Protection (DEP) - DEP has statutory control over pollution and the allocation of Federal funds for sewerage facilities. Water supply responsibilities include interstate transfers of water. This department is also concerned with the inspection of dams and marinas, flood control work, th eestablishment of channel encroachment lines and the control of dredging activities.

The Comprehensive Planning Division of the Office of Policy and Management (CPD/OPM) - CPD/OPM is concerned with comprehensive policies and planning and is a participant in the Interagnecy Water Resources Planning Board.

The Interagency Water Resources Planning Board (IWRPB) - The IWRPB contains representatives from the Departments of Environmental Protection and Health and the Office of Policy and Management, Comprehensive Planning Division. Its basic responsibility is to jointly prepare a statewide long range plan for the management of the water resources of the State and other related responsibilities as directed by state law. Further, it is directed to establish a continuing planning process and to prepare and periodically update the water resource management plan.

Regional Institutions

The Southeastern Connecticut Regional Planning Agency, as the name suggests, is responsible for the areawide approach to all aspects of planning and development at the local level. The RPA engages in comprehensive planning in coordination with t he overall water resources planning being conducted by the State. Presently, a major effort whivh the regional planning agencies in Connecticut are engaged in is Section 208 areawide waste treatment management palnning in compliance with the Federal Water Pollution Control Act Amendments of 1972.

Coordination

To insure that water resources plans developed during the study are implementable, close coordination will be made with local, State, regional and Federal agencies regarding the formulation of institutional arrangements. Each alternative will contain a number of alternative implementation arrangements which may require different institutional arrangements.

STUDY MANAGEMENT

Study management is concerned with the entire conduct of the study. This Reconnaissance Report, being subject to revision as study plans are refined or modified, is intended to serve as the overall guide to management of the study. All parties responsible for the study will insure that the various tasks and schedules outlined will be strictly followed.

Strong study management is needed to assure a sound and orderly process leading to plan selection. In order to achieve this, study management will be provided by the Corps of Engineers and an advisory group. This proposed organizational pattern will be used as a ruide and may be modified as the needs of the planning effort become more firmly established.

Study Responsibility

The Division Engineer, New England Division, U.S. Army Corps of Engineers, will have overall responsibility for the conduct and management of the flood plain management study. An advisory group will be organized early in the study.

The day-to-day management of the study will be the responsiblity of the study manager. A multidisciplinary unit will comprise the study team. Study coordination will be accomplished by the Basin Management Branch, augmented by expertise provided by other offices in the Division organization.

Study progress will be monitored by the study manager, who will be responsible for the time, cost and work effort schedules outlined in the Reconnaissance Report. Modifications to the report will be the responsibility of the Corps of Engineers in response to recommendations from the advisory group.

Coordination

The advisory group will provide technical and nontechnical inputs to the study and participate in the public involvement program. This group will include representatives of Federal, State and local agencies, environmental organizations, interest groups from the industrial sector, academic institutions, civic organizations and the general public. The advisory group will:

- Serve as advisors on programs and major work items.
- Participate in public involvement activities.
- Coordinate their respective agency's policies and programs with the study.

STUDY SEQUENCE

The tidal-flood plain management study will be conducted in three stages: Stage I - The Reconnaissance Report; Stage II - Development of Intermediate Plans, and Stage III - Development of Final Plans.

Planning will consist of executing four functional planning tasks during each of three stages of plan development. These tasks are problem identification, formulation of alternatives, impact assessment and evaluation.

Iteration of these tasks during any of the planning stages may be necessary and even desirable in order to reflect an increasing level of effort, detail and refinement. Iteration also provides for the incorporation of additional information to the study as it progresses.

The following paragraphs describe the stages of plan development and the major tasks of the planning process.

Stage 1

The prupose of the Reconnaissance Report, the initial stage of the study effort, is to recommend, if deemed necessary, the advisability of continuing with more detailed study. Effort at this stage provides a clear indication of the scope of needs, the precise study area's planning objectives, specific constraints that have been identified and the scheduling and management of subsequent planning activities.

Stage II

Development of Intermediate Plans will concentrate on a more detailed analysis of the problems as well as the development of a preliminary range of solutions at a general level of detail, assessment and evaluation. The development of alternative plans (structural, nonstructural, and without condition) will emphasize interaction between problem identification and plan formulation in an attempt to assure public understanding of the basic issues. The final product of this stage will constitute the basis for determining the scope and direction of planning efforts under Stage III.

Emphasis will be placed on public involvement and workshops and screening of alternatives through impact assessments, trade-offs and compromises which might improve an alternatives desirability and indicate which alternatives are clearly unacceptable. Assessments of economic, environmental, social and regional impacts of each alternative will receive greater emphasis than in Stage I.

. Evaluate the plans against existing and future if no Federal action conditions; determine the acceptability of plans, while considering mitigation measures; screen out the unacceptable plans; and determine those few plans which warrant detailed study in Stage III-through public involvement.

Stage III

Development of Final Plans will concentrate on developing a select number of more detailed alternative tidal-flood plain management plans. Extensive public involvement and professional evaluation will be used in order to determine which plans will be evaluated in this stage. Several iterations of the four basic tasks may be needed in order to achieve adequate detailed planning. As a result of Stage III, an array of alternative tidal-flood plain management plans will be formulated that are responsive to study objectives and the problems and concerns of the Thames Estuary.

PLANNING PROCESS

The planning process to be followed during each stage incorporates the four basic planning functions of problem identification, formulation of alternatives, impact assessment and evaluation.

Problem Identification

This task serves to identify the tidal-flooding problems the overall study will address and to establish study planning objectives. This will require the development of a regional profile of environmental, social and economic

conditions for the study area. The study objectives will guide formulation of alternatives whereas the regional profile will serve as a base condition for determining impact assessment and evaluating capabilities of alternatives.

Formulation of Alternatives

Formulation is the process of developing alternative tidal-flood plain management systems which respond to identified problems and concerns and the study area planning objectives. All potential measures available for problem solution will be identified, and both structural and nonstructural measures will be considered by developed plans.

Impact Assessment

This function includes tasks required to determine the effect of each alternative plan on existing social, economic and environmental conditions. These effects will be measured over the impact zone and evaluated as to time of occurrence.

Evaluation

The evaluation function involves work tasks needed to measure and compare the relative values of each alternative plan, particularly in response to achieving the study objectives. Benefits and losses associated with the development of each plan will be described in order to effectively analyze possible trade-offs between plans and to recommend actions.

DATA COLLECTION AND BASIC STUDIES

Data needed as the foundation form major work tasks will be generated at the earliest practical date in the study. The efforts required in the basic studies areas of the planning process are described briefly in the following paragraphs.

Socio-Economic Studies

As mentioned previously, studies identifying and evaluating present and future socio-economic conditions in the study area will be developed. Population projections and economic data, including industrial growth and land development trends, will be used to assess and evaluate the impacts and study objectives achieved by alternative tidal-flood plain management plans.

Land Use Studies

Data developed by local or regional agencies will be taken into consideration in the assessment of present and future conditions.

Institutional Arrangements Study

A preliminary survey of major public institutions was initiated during preparation of the Reconnaissance Report. A more detailed survey will be undertaken during Stage II in order to develop pertinent data on task capability

potential of the various Federal, State, regional and local public institutions in the study area. Organization charts, annual reports, legislation, capital budgets and other public documents will be scrutinized to develop a data base on each agency's legal authority, functional role, spatial authority, program responsibility, manpower, organizational and financial structure. Information on and analyses of institutional capabilities for this study will be used to evaluate the capabilities of institutions to implement each alternative plan. Conclusions will be made for each alternative plan as to the need for the modification of existing institutions or legislation or the creation of new institutions or legislation to implement plans.

MAJOR WORK ITEMS

A brief description of the various efforts to be performed in the development of a tidal-flood plain management system is presented below. The efforts are described for each of the four functional tasks of the planning process, problem identification, formulation of alternatives, impact assessment and evaluation. The actual plans will be developed concurrently in order to formulate the best overall solution.

Problem Identification

Flood problem identification, in subsequent stages of this study, will concentrate on detailed surveys and hydraulic and economic studies in the areas subject to flooding. In those areas where changes are expected to have a significant impact on runoff conditions, existing and future land use data and economic and environmental conditions will be analyzed to determine the effects of the changes.

Plan Formulation, Impact Assessment and Evaluation

Formulation of the alternative tidal-flood reduction plans for Thamesville will consider both structural and nonstructural measures to satisfy its tidal-flood management needs. Study efforts will include the accomplishments of detailed hydrologic investigations, hydraulic studies, foundation and materials studies, construction design studies, surveys, relocations and real estate consideration. Nonstructural measures such as flood insurance, permanent evacuation, floodproofing and zoning ordinances will be considered in lieu of and in conjunction with structural alternatives.

Assessment and evaluation will include benefit/cost analyses of formulated alternatives. Economic, social and environmental assessments will be made and impacts on the study area resulting from plan implementation will be evaluated. Tidal-flood control and tidal-flood plain management alternatives will be selected for the NED and EQ plans.

SCHEDULING AND COSTS

As noted previously, the Thamesville Tidal-Flood Plain Management Study will be undertaken in three time-phased stages to help facilitate management by specifying at least three points for monitoring study progress and scope, while providing for the orderly development of plans.

Detailed breakdowns of each of the major work items being undertaken in the study were conducted to develop time schedules, task sequence and cost allocation. The proposed scheduling for the entire study is shown on Plate 3. This schedule indicates the anticipated starting and completion dates of the various work tasks to assure their completion prior to the time outputs will be required for subsequent tasks.

The overall schedule shown on Plate 4 was designed to accommodate the most optimistic funding schedule envisioned for this study. Costs have been prepared for these three stages as shown on the work schedule. No cost sharing is required for accomplishment of the study. The overall study effort is estimated at $378,000. Below are estimated costs by stage.

Stage I	$ 85,000
Stage II	197,000
Stage III	96,000

FINAL REPORT

The intervening findings of the study will be continually documented during the process of the study. Upon completion of all work efforts, the final report will consist of a summary report with these supporting appendices.

Appendices

1	Problem Identification
2	Formulation, Assessment and Evaluation of Detailed Plans
3	Public Views and Responses
4	Engineering Investigations, Design and Cost Estimates
5	Recreation and Natural Resources
6	Social and Cultural Resources
7	Economic
7	Others as Needed

Continuous drafting of these documents will be required throughout the progress of the study to assure that study progress and findings are given a maximum amount of public exposure. The product of Stage II will result in the preparation of the draft Background Information Appendix and a chronological draft of the Plan Formulation Appendix. Analysis of these study documents by all study participants will form the basis for decisions regarding Stage III planning accomplishments.

SECTION IV

PRELIMINARY INVESTIGATIONS

ALTERNATIVE SCHEMES OF PROTECTION

Flooding problems were intially identified throughout the Thames River Basin. Possible structural and nonstructural solutions for each problem were then analyzed.

This section, therefore, will contain material relative to structural, nonstructural, and without condition alternatives.

The most positive way to reduce or control floods and associated damages in heavily urbanized flood prone areas is to use structural corrective measures.

Partially because of high tangible costs that can be associated with structural methods and environmental opposition to these methods, emphasis is shifting to nonstructural plans, which attempt to restrict usage of damage-prone areas so that the losses will be decreased. Considerable damage reduction can be achieved this way.

The without condition program involves no Federal flood control program but can be implemented by the local governments with a minimum amount of additional effort.

Structural Measures

. Structural components are often the most practical way to control floods and reduce damage in heavily urbanized flood prone areas if they are not environmentally or socially undesirable.

. Land treatment measures reduce erosion and runoff, and lessen the damaging movement of sediments to streams and flood plains. Vegetative and mechanical measures developed for conservation practices--contour farming, cover cropping, terracing, critical area planting, and the like--are also effective on rural lands undergoing development.

. Reservoirs for impounding uncontrolled floodwaters provide a high level of protection to downstream communities, while satisfying other needs, such as water supply and public recreation.

. Walls and dikes confine floodflows to the channel or floodway and provide protection to local high risk areas.

. Reservoir management programs provide for the addition of flood control storage in existing reservoirs, with controlled release after the flood danger passes.

. Hurricane barriers use walls, dikes, gates, and pumping facilities to prevent high tides from intruding and raising flood heights along the lower main stem.

. Stream improvements can increase the flood carrying capacity of floodways by eliminating abrupt turns, widening and deepening channels, improving areas at bridges and culverts, alleviating erosion problems, and

removing shoals, sandbars, islands, overhanging and uprooted trees, and accumulated debris. Diversion of floodflows to bypass heavily congested flood prone areas offer great protection while minimizing environmental and social impacts.

The following section is a detailed analysis of the LISS-Thamesville Local Protection Project which consists of walls and dikes.

Liss-Thamesville Local Protection Project

General - The local protection project at Thamesville could be located along the west bank of the Thames River in Norwich, Connecticut approximately 12 miles upstream of Long Island Sound. The plan of protection would provide for construction of 2,300 feet of earth dikes, 200 feet of contrete "T" type floodwalls, 750 feet of concrete bulkwalls, a pumping station to handle interior drainage, two railroad stoplog structures and other appurtenant works. The project would provide protection against the Standard Project Flood for the 35 acres of land within the U-shaped industrial site (see Plate 4).

Estimate of Costs

. Basis of Estimates - Topographic maps of the U.S. Geological Survey, on a scale of 1:24,000 with 5-foot contours, were supplemented by field survey of the studied dike alignment and adjacent areas. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide safe and adequate structures.

Unit prices are based on current average bid prices for similar construction projects in the Connecticut area.

. Contingencies, Engineering and Overhead - To cover contingencies, construction and relocation costs have been increased by 20 percent. Engineering and Design costs are 11 percent and supervision and administration costs are 8 percent of the construction cost.

. First Costs - A detailed breakdown of first costs for the recommended project is shown in Table 2.

. Annual Charges - The estimate of Federal annual charges is based on interest at 7-1/8 percent on the Federal investment plus the amount required to amortize the investment over the assumed 100-year life of the project (see Table 3).

Pertinent Data

Purpose - Tidal Flood Protection

Location of Project

State	Connecticut
County	New London
City	Norwich
River	On the Thames Estuary approximately 12 miles upstream from Long Island Sound.

TABLE 2

ESTIMATED FIRST COSTS
THAMESVILLE LOCAL PROTECTION PROJECT
NORWICH, CONNECTICUT

ITEM	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
Site Preparation	1	Job	LS	$ 10,000
Random Fill	4,000	CY	$3.00	12,000
Impervious Fill	73,200	CY	4.00	292,800
Class A Stone	21,800	CY	28.00	610,400
Gravel Bedding	16,100	CY	12.00	193,200
Reinforced Concrete	7,300	CY	200.00	1,460,000
Compacted Gravel	52,000	CY	8.25	429,000
Dumped Gravel	27,700	CY	8.25	228,500
Uncompacted Processed Gravel Fill	3,700	CY	15.00	55,500
Crushed Stone	200	CY	7.00	1,400
PZ-38 Sheeting	37,500	SF	22.00	825,000
HP 12 x 53 - 3' O/C	18,700	LF	35.00	654,500
24" Ø RCP	750	LF	70.00	52,500
Pump Station	1	Job	LS	500,000
Excavation	113,700	CY	4.00	454,800
Underdrains	750	LF	14.00	10,500
2 Stoplog Structures	1	Job	LS	50,000
				5,840,000
Contingencies (20%)				1,168,000
Construction Cost				7,008,000
Engineering and Design (11%)				770,880
Supervision and Administration (8%)				560,640
Total First Cost of Project				$8,340,000

Type of Improvement

Earth dikes, reinforced concrete and steel sheet piling, bulkwalls, concrete T-walls, two railroad gate structures, one pumping station, and other appurtenant works.

Hydrology

Local Protection Area	35 acres
Drainage Area	325 acres
Adopted Pumping Requirements	109.2 cfs

Embankments

Type	Rolled Earthfill with rock facing
Elev. Top of Embankment	25.0 NGVD
Total Length	2,300 feet
Maximum Height	50 feet
Slopes	1 on 2 landside 1 on 1.5 riverside
Top Width	10 feet

Floodwalls

Type	Reinforced concrete "T" walls
Elev. Top of Wall	25.0 NGVD
Total Length	200 feet
Top Width	1.5 feet

Bulkhead Walls

Type	Reinforced Concrete and anchored steel sheet piling
Elev. Top of Wall	25.0 NGVD
Total Length	750 feet
Top Width	2.0 feet (I-wall)

Nonstructural Measures

Regulatory measures discourage the use and development of the flood plains, thus lessening the threat of flood damage and possible loss of life.

Flood plain regulations help avoid repetition of past building errors by preventing additional construction on already developed flood plains. Communities may adopt more stringent regulations than those required by the National Flood Insurance Program. Such restrictions require the enactment of ordinances to implement and enforce land use planning programs involving the delineation of flood hazard areas.

Encroachment lines drawn on the map on each side of a watercourse show the lateral limits within which development must be restricted in order to preserve the flood carrying capacity of the stream and prevent further growth in the flood plain. The central portion, or floodway, consists of the stream channel and that portion of the adjoining flood plain required to pass a 100-year flood. No construction or filling should be allowed there, although parking lots, recreation, agriculture, and other nonstructural uses may be permitted, provided that the free flowing state of the floodway is not impaired.

The floodway fringe is the remainder of the 100-year flood plain. Limited encroachment or filling may be allowed here, providing it does not cause the water level of the 100-year flood to rise more than one foot (or less if so established by state or local regulation). Any construction here must be floodproofed to the 100-year flood level.

Zoning is the legal measure used to enforce land use and development restrictions in the flood plain by governmental agencies. It can insure the safekeeping of this property for the health, welfare, and safety of the public.

Subdivision regulations are used by local governments to control construction in undeveloped flood plains by specifying minimum elevations, drainage, location restrictions, and other conditions to prohibit encroachment in flood hazard areas.

Land use programs for conservation, scenic, and flood control purposes may include land use restrictions, purchase of land use rights, lowering of tax assessments, and other measures to meet public objectives--such as preventing development in flood plains--while allowing continued private ownership of the land.

Other regulatory measures to lessen the threat of flood losses include:

. Building codes specify minimum standards of design, construction, and quality of materials to reduce potential flood damages in structures whose location in flood hazard areas cannot be prevented. Such restrictions could prevent buildings from floating off their foundations, establish minimum basement and first floor elevations consistent with potential flood occurrences, prohibit basements that would be subject to shallow flooding, require reinforcement to withstand water pressure or high velocity flow, restrict the use of materials which deteriorate rapidly in water, and prohibit equipment that might be hazardous to life when submerged.

. Urban redevelopment presents opportunities to remove developments from the flood plain and make sure that new construction in the flood plain is designed to withstand flooding.

. Tax adjustments on land dedicated to open space uses, such as agriculture, recreation, and conservation helps to preserve undeveloped flood plains.

. Warning signs of previous high water levels warn prospective buyers that a flood hazard exists. Required certification by sellers that the property is reasonably flood free is even more effective.

. Health and fire regulations should include contingency plans for temporary evacuation of people, property, and livestock from low-lying areas, prevention of disease should water supplies become polluted or sanitation facilities inoperative, accessibility to fire fighting equipment, and emergency fire reporting systems.

. Cleanup campaigns to remove material dumped in flood prone areas and prevent future dumping may be instituted.

. Flood forecasting can reduce property losses significantly and save lives. Information from the Federal government's extensive weather forecasting system should be effectively disseminated at the local level.

Without Condition

This alternative would consist of the without condition program - one that local interest would implement in the absence of a corrective Federal assistance program. It is assumed that local interest would institute a program for controlling growth within the 100-year flood plains, at least the minimum zoning controls required for eligibility in the National Flood Insurance Program. The plan would be equally applicable to both main stem zones, and all major tributary streams.

As this alternative would exclude the consideration of structural components, reduction in flood stages for alleviating damages in flood prone areas would be unattainable. Some intensification of flood problems could be expected in varying degrees because of continuing urbanization within the basin with the program. If the without condition alternative is not implemented as a minimum program, flood problems can be expected to magnify over the years.

This alternative includes the only means available for compensating losses due to flooding, through municipal and individual participation in the National Flood Insurance Program. However, flood losses would be only partially covered as there are no existing provisions for compensating policyholders for non-physical losses, such as expenses for lodging during dwelling rehabilitations or loss of income or profit while a commercial or manufacturing firm is temporarily closed. In addition, the uninsured would receive no monetary compensation; such a condition could result if municipalities do not participate in the National Flood Insurance Program, which includes the requirement that flood plain zoning to the 100-year event be instituted.

ECONOMIC ANALYSIS

701,200

A reconnaissance scope damage survey of the Thamesville area in Norwich, Connecticut was carried out to determine an estimated benefit-cost ratio (the stage-damage curve is shown in Figure 2). Average annual losses for the entire local protection study area are estimated to be ~~$690,000~~. Assuming flood control improvement implemented effective to the 100-year event elevation, average annual benefits would be ~~$680,000~~ (the damage-frequency curve is shown in Figure 3), Benefit-Cost Raio 1.06 to 1.0. Heavy sampling of industry and commercial establishments was carried out in a field investigation to arrive at these figures. A detailed analysis of the costs are in Table 3.

693,200

TABLE 3

BENEFIT-COST RATIO

TOTAL INVESTMENT	
First Cost	$8,300,000
Interest During Construction (7-1/8%) T=3 yrs	887,000
Total Investment	$9,187,000
TOTAL ANNUAL CHARGES	
Interest (7-1/8%)	$ 654,570
Amortization	680
Total Annual Charge	$ 655,250
Total Annual Benefit	$ 693,200

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Within the study area is the potential for severe flood damages caused by future development. The Thamesville area of the Thames River Study will be directed toward formulation of a flood plain management plan to meet these problems.

Tidal flooding has been identified as a potential problem in this area and preliminary investigations have indicated that the Standard Project Hurricane (SPH) would cause enormous damage.

An increase in future urbanization and encroachment on the flood plains can be expected to increase flood damages and magnify the problems that exist in the Thamesville area of the Thames River.

The Thamesville Area Study will develop and evaluate the problem areas mentioned above and recommend measures for flood plains and protection against coastal and tidal flooding.

One such plan is the Thamesville Local Protection project which is detailed in Section IV. This project will protect the immediate area from inundation thereby preventing a possible loss of revenue. The project has a favorable benefit-cost ratio. An environmental benefit is the protection of the existing shoreline.

Stage II will also include nonstructural alternatives for if the local protection project is unacceptable, the recommended plan could be a nonstructural plan.

RECOMMENDATIONS

The Division Engineer recommends that study efforts proceed with the initiation of Stage II as outlined in this Reconnaissance Report. The structural and nonstructural alternatives will be analyzed further in that report.

SECTION VI

APPENDICES

APPENDIX A

FISH AND WILDLIFE

AND

PERTINENT CORRESPONDENCE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

SEP 25 1979

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This is a planning aid report prepared to assist you in your flood control study on the Thames River in Thamesville, Connecticut. The information provided is a preliminary fish and wildlife resource inventory of the study area.

The banks of the Thames River in the study area have been heavily urbanized. Industrial and residential developments run right to the shoreline. The vegetation remaining is that which is consistent with a developed locale. The area still provides habitat for urban wildlife including songbirds and small mammals such as rabbits and squirrels.

The river is a broad tidal estuary extending 12 miles northward from New London Harbor to Norwich. In past decades, the Thames has been degraded by industrial and municipal pollution. Inadequately treated waste waters and direct industrial discharges contributed high levels of organics and heavy metals to the system. However, with the passage of the Federal Water Pollution Control Act combined with State and Federal enforcement, the water quality is improving. A saltwater wedge is experienced all the way to Norwich, producing a buffering effect on river temperature.

The river supports a very significant fishery population. Its waters are used for feeding and as spawning and nursery grounds for a variety of species. There remain small commercial fisheries for bluefish, Atlantic tomcod, striped bass, winter flounder, American eel and alewife. The Thames supports a heavily utilized sport fishery for winter flounder, striped bass, white perch, American smelt, bluefish and Atlantic tomcod. Mummichog and Atlantic menhaden are the most common forage species.

The Connecticut Department of Environmental Protection has placed a high priority on the restoration of anadromous fish in the two principal tributaries to the Thames River, the Shetucket and Quinebaug Rivers. Historical records show that the drainage formerly supported sizable runs of American shad, Atlantic salmon and alewives. Studies partly funded under the Anadromous Fish Act (PL 89-304) are being conducted to

determine the potential for establishing runs of Atlantic salmon, coho salmon, sea-run brown trout, American shad, alewife and blueback herring. Restoration plans will include the construction of fishways on the dams to provide upstream access. The preliminary results of this study have been reported in:

> Hames, Richard L. (Ed.). 1975. An Evaluation of the Fishery Resources of the Thames River Watershed, Connecticut. Storrs Agricultural Experiment Station. Bulletin 435.

The final report is being drafted and should be available for review by the end of November 1979.

Although their populations were once depleted, blue crab is making a comeback in the estuary and does provide a small recreational fishery. The river produces oysters and hard-shell and soft-shell clams but they are not taken for direct consumption due to high coliform counts.

The river provides very limited habitat for dabbling ducks but is very important to diving ducks which are distributed along the estuarine reach. Waterfowl usage is primarily for wintering and during migration periods. During the fall, many sportsmen hunt the river shoreline, primarily for black duck, goldeneye and mallard.

We understand that flood control alternatives are in the initial stage of review. We recommend that nonstructural alternatives be pursued such as flood proofing, which would have minimal adverse impacts on this natural resource. We appreciate the opportunity to comment on this local protection study. We request the opportunity to provide additional comments as plans are developed.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

Enclosures

Enclosure (1)

Seasonal means of temperature, dissolved oxygen, and salinity near project site.

Season	Depth	Temperature	D.O.	Salinity
Winter	1 m	1.3	13.5	1
	5 m	2.3	10.9	25
Spring	1 m	8.5	12.3	3
	5 m	6.3	10.0	24
Summer	1 m	23.8	4.9	8
	5 m	18.1	0.3	23
Autumn	1 m	17.5	6.5	5
	5 m	18.8	0.7	31

Temperature = (C)
D.O. = (mg/l)
Salinity = (ppt)

Enclosure (2)

Common fish species found in the Thames River estuary.

Blueback herring (Alosa aestivalis)
Hickory shad (Alosa mediocris)
Alewife (Alosa pseudoharengus)
American shad (Alosa sapidissima)
American eel (Anguilla rostrata)
Fourspine stickleback (Apeltes quadracus)
Atlantic menhaden (Brevoortia tyrannus)
White sucker (Catostomus commersoni)
Atlantic herring (Clupea harengus)
Weakfish (Cynoscion regalis)
Carp (Cyprinus carpio)
Chain pickerel (Esox niger)
Tessellated darter (Etheostoma omstedi)
Banded killifish (Fundulus diaphanus)
Mummichog (Fundulus heteroclitus)
White catfish (Ictalurus catus)
Tidewater silverside (Menidia beryllina)
Atlantic tomcod (Microgadus tomcod)
Largemouth bass (Micropterus salmoides)
White perch (Morone americana)
Striped bass (Morone saxatilis)
Spottail shiner (Notropis hudsonius)
Atlantic mackerel (Scomber scombrus)
Smelt (Osmerus mordax)
Yellow perch (Perca flavescens)
Bluefish (Pomatomus saltatrix)
Winter flounder (Pseudopleuronectes americanus)
Brown trout (Salmo trutta)

DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

28 March 1979

Colonel Max B. Scheider
Deputy Division Engineer
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Water Resources Study -
Connecticut Coastal Study

Dear Colonel Scheider:

I am in receipt of your notification of the above-referenced coastal study. Presently, this office is undertaking studies of coastal erosion and flooding at selected locations of Connecticut's shoreline. Also, we intend to undertake a long-range investigation and data collection program for Connecticut in order to more effectively deal with our coastal erosion and flooding problems.

The aspects of your study dealing with protection against tidal flooding is directly applicable to the type of investigation we would like to pursue. We would like to coordinate this effort with you whenever possible, however, the seven sites you mention will not be studied for sometime in the future. If at all possible, please send me an outline of specific work elements to be incorporated into your program so that our future study will not duplicate your efforts.

Considering the magnitude of work usually required in protection against tidal flooding, the Department of Environmental Protection is in strong support of federal participation in these types of projects. If this office can be of any assistance to you in this study, please don't hesitate to contact me.

I look forward to hearing from you on this matter.

Sincerely,

Paul Biscuti

Paul Biscuti
Civil Engineer
Water Resources Unit
Tel. no. 203-566-7244

PB:ljk

CITY OF NORWICH
CONNECTICUT

April 23, 1979

Colonel Max B. Scheider
Deputy Division Engineer
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Proposed investigation by U.S. Army Corps of Engineers into alternative ways of protecting lives and property through the use of various combinations of non-structural and structural flood damage reduction technique

Dear Colonel Scheider:

In reply to your letter dated November 27, 1978, concerning the proposed study described above, I wish to advise you that the City of Norwich is not aware of any ongoing or potential future activities within the Thamesville section of Norwich, Connecticut which would duplicate in any way the study you propose to make. Furthermore, the City feels that such a study would be most beneficial to the future development of the Thames River Basin and to the City of Norwich.

Please contact Mr. J. Thomas C. Waram, the Planning Director for the City of Norwich, regarding any information you may require in connection with this study, and he will coordinate your requirements with any other City agencies you may wish to consult with. (His address is Room 304, City Hall, Norwich, Connecticut 06360, and the

telephone number is (203) 887-6250 or (203) 887-1400).

Very truly yours,

Charles C. Whitty

Charles C. Whitty
City Manager

CCW:bmj

cc: Director of Public Works
Planning Director

CITY OF NEW LONDON
CONNECTICUT

December 11, 1978

Mr. Max B. Scheider
Colonel, Corps of Engineers
Deputy Division Engineer
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider:

Reference is made to your November 27 communication concerning your resource study of the Connecticut coastal area addressed to former Mayor Uguccioni.

Be advised that the only information the City of New London has with regard to protections against tidal flooding as a follow up to the Long Island Sound Regional Study is information prepared by the Corps of Engineers.

We will be happy to cooperate with you in your investigation.

Very truly yours,

C. Francis Driscoll
City Manager

D:b

cc: Development Coordinator
City Engineer

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

December 11, 1978

Colonel Max B. Scheider
Deputy Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider

Re: NEDPL-BC

Thank you for your letter of November 27, 1978 advising us of the selection of the Thamesville section of Norwich, Connecticut, as the initial study area for an evaluation of the feasibility of Federal participation in tidal flood damage reduction measures at seven specific flood prone areas along the Connecticut coast. The assignment of the next priority to the Pine Creek, Fairfield Beach, Jennings Beach and Ash Creek sections of Fairfield is particularly noted.

We look forward to being informed of your study findings.

Sincerely,

Stanley J. Pac
Commissioner

SJP:jbo

STATE OF CONNECTICUT
STATE DEPARTMENT OF HEALTH
79 ELM STREET HARTFORD, CONNECTICUT 06115

OFFICE OF PUBLIC HEALTH
Telephone: 566-5646

December 27, 1978

Re: NEDPL-BC

Department of the Army
Max B. Scheider
Colonel, Corps of Engineers
Deputy Division Engineer
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider,

We appreciate receiving your letter of November 27, 1978 regarding the Corps investigating ways to reduce flood damage in seven tidal flood prone areas in Connecticut. In regards to activities that this department is involved in that may have a bearing on your work, we have checked our inventory of public supply wells in the areas mentioned and have enclosed maps showing the location of certain wells that may be of concern from the standpoint of salt water intrusion. These are the Westport Well Field along the Saugatuck River in Westport and the Brookside Well along the Mill River in Fairfield, both owned by the Bridgeport Hydraulic Company, and some small public wells very near the shoreline in Old Lyme as the town does not have a large central water system.

We would be happy to supply any additional information on these wells and would appreciate learning of any activity proposed that might encourage salt water intrusion to these supplies.

In addition, the shellfish sanitation program is concerned with preventing the consumption of shellfish which may contain contaminants hazardous to health While the areas indicated are already closed to shellfishing because of possibl contamination, work in one area, Saugatuck Shores may affect the area south of the demarcation line which is open or closed depending on rainfall. Closures in this open area are based upon a relationship of increased total coliform counts when rainfalls of 0.5 inches or more occur. Commercial shellfish beds a also located in this area. If structural methods are employed, our department would be concerned with any elevations in total coliform counts due to soil spo age or erosion. By law our department must close an area to shellfishing if th median total coliform counts exceed 70 MPN/100 ml.

The Mosquito Control Section in this department may have some concern over the possible filling or blockage of Trenches. Comment on this matter will come in a separate letter.

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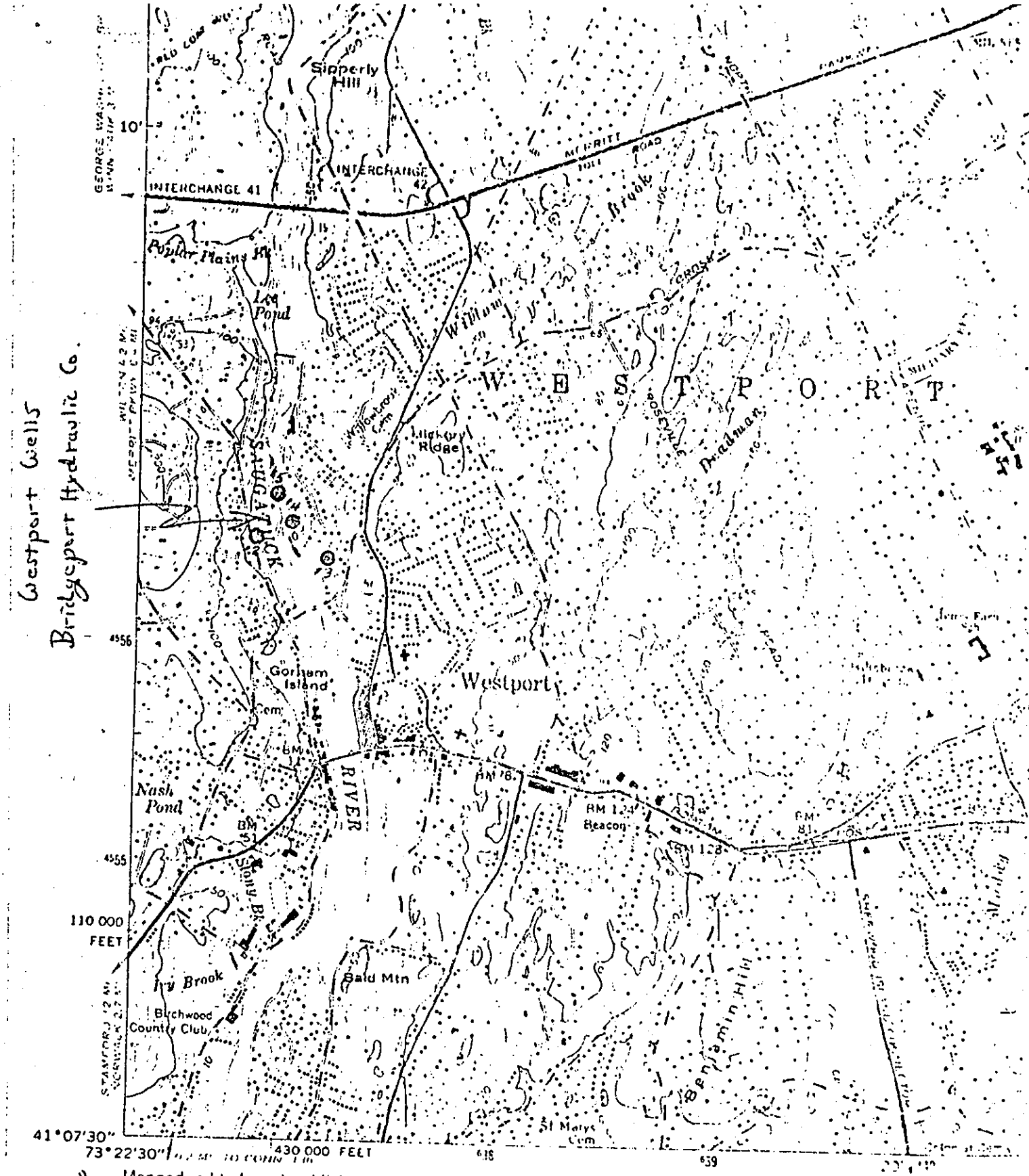
The Aqua Culture Division of the Department of Agriculture may also provide a separate response concerning the possible silting or other damage to shellfish growing areas.

Sincerely,

Theodore C. Willerford

Theodore C. Willerford
Principal Sanitary Engineer
Environmental Health Services Divisio

TCW/fz
Enclosures

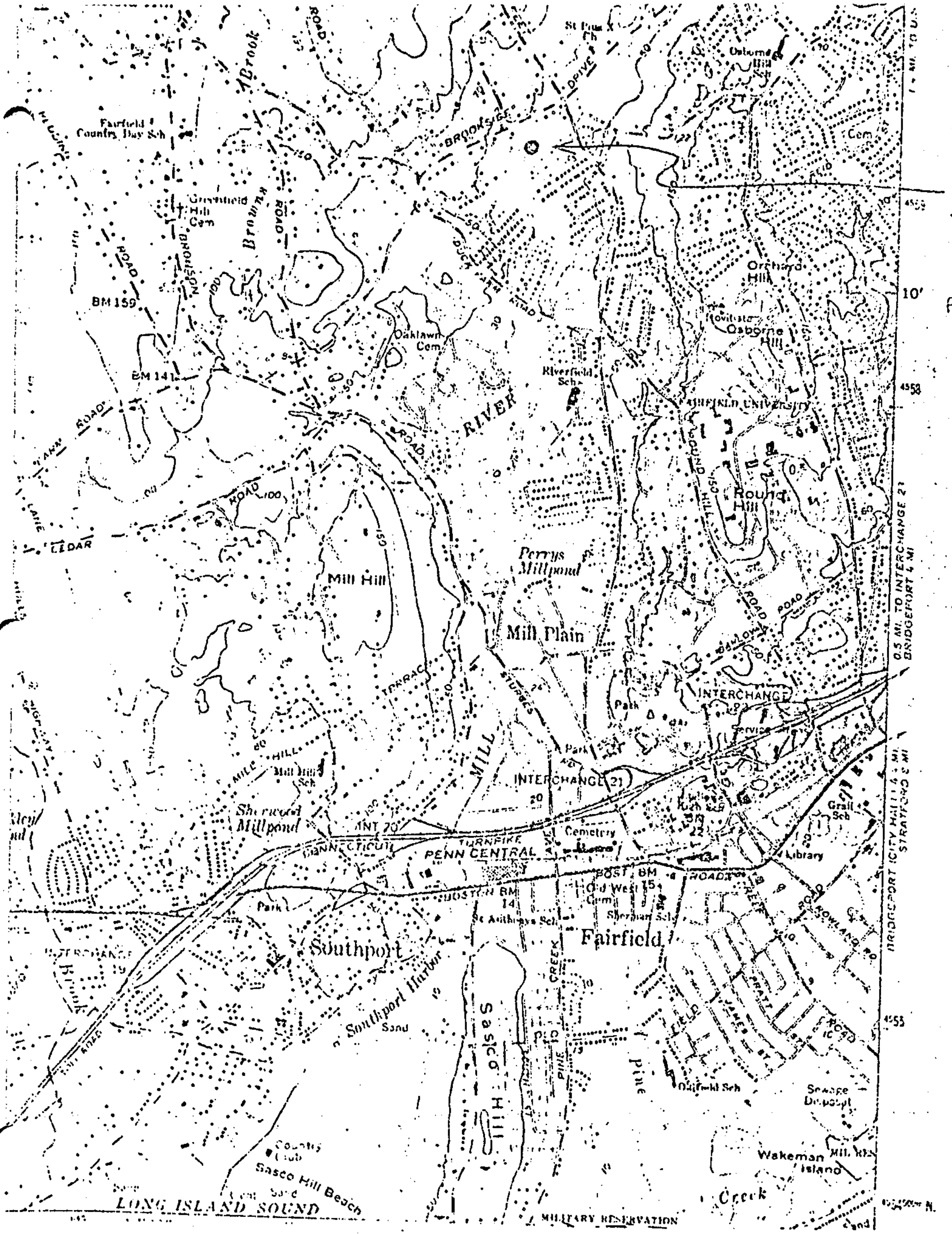


Mapped, edited, and published by the Geological Survey

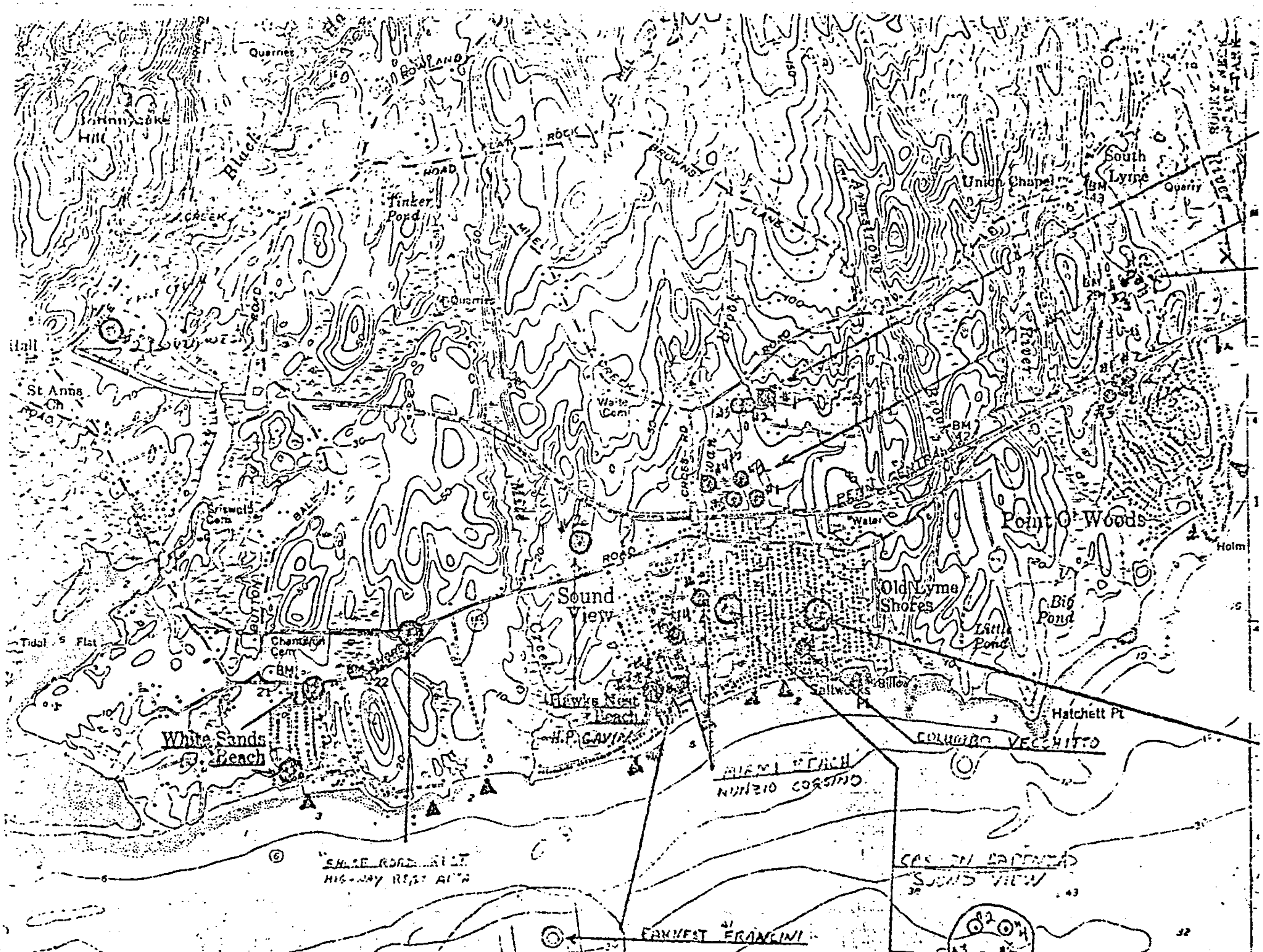
Control by USGS, USC&GS, USCE, and Connecticut Geodetic Survey

Topography by photogrammetric methods from aerial photographs taken 1949. Field checked 1951. Revised 1960

Selected hydrographic data compiled from USC&GS Chart 220 (1960)
This information is not intended for



Fairfield Country Day Sch
Greenfield Hill Cem
BM 159
BM 141
Browns Brook
BROOKSIDE DRIVE
Oaklawn Cem
Riverfield Sch
RIVER
Osborne Hill
Orchard Hill
Osborne Hill
FAIRFIELD UNIVERSITY
Round Hill
Perrys Millpond
Mill Hill
Mill Plain
CEDAR ROAD
MILE HILL
Mill Hill Sch
Sherwood Millpond
INTERCHANGE 21
INTERCHANGE
CONNECTICUT TURNPIKE
PENN CENTRAL
Cemetery
BOSTON POST ROAD
BM 14
BM 15
Old West Cem
Sherman Sch
St Anthonys Sch
Fairfield
Southport
Southport Harbor
INTERCHANGE 19
Sasco Hill
PINE CREEK
Pine Creek
Oldfield Sch
Sewage Disposal
Grail Sch
Library
ROWLAND ROAD
PRATT ST
Wakeman Island
Country Club
Sasco Hill Beach
LONG ISLAND SOUND
MILITARY RESERVATION
0.5 MI. TO INTERCHANGE 23
BRIDGEPORT 4 MI
BRIDGEPORT (CITY HALL) 4.5 MI
STRATFORD 8 MI
10′


Quarries
ROWLAND
Johnnycake Hill
Black
ROCK
ROAD
BROWNS
LANE
Tinker Pond
CREEK
Quarries
St Anns Ch
Waite Cem
Griswold Cem
Union Chapel
South Lyme
Quarry
Water
Point O' Woods
Holm
Sound View
Old Lyme Shores
Big Pond
Little Pond
Tidal Flat
Champlin Cem
White Sands Beach
Hawks Nest Beach
Saltworks Pt
Hatchett Pt
NUNZIO CORSINO
EARNEST FRANCINI